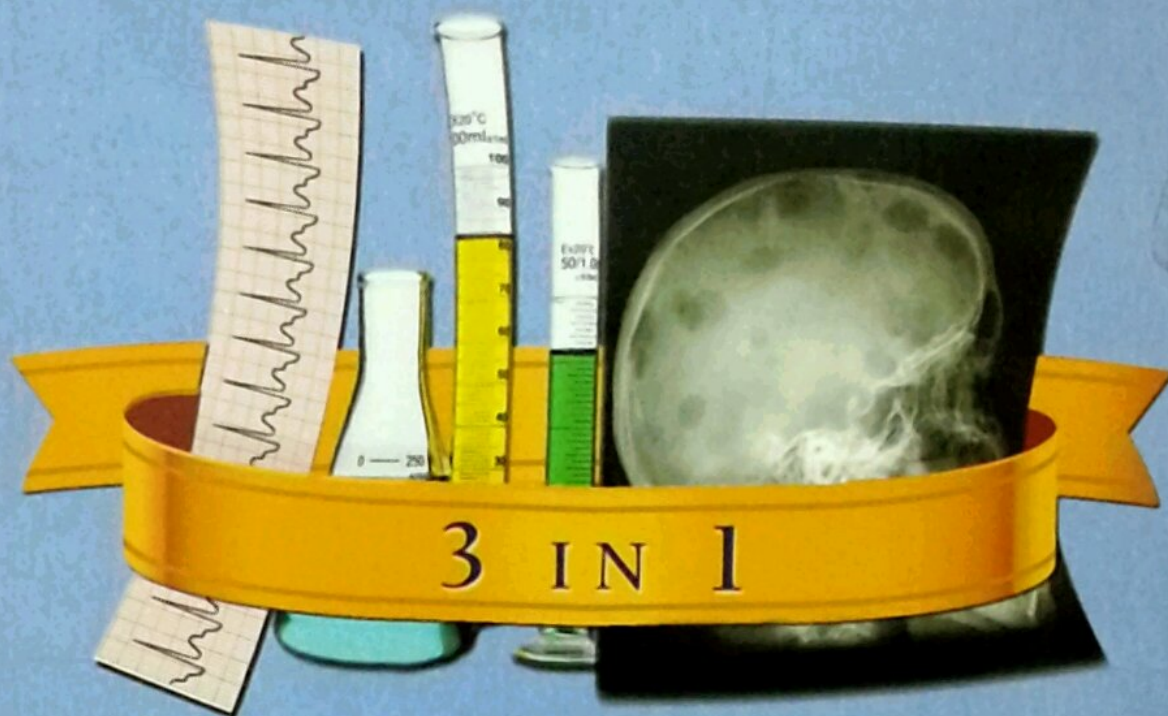


# PARACLINICAL MADE EASY



SUPPORTED BY  
VIDEO LESSONS ON CD

X-RAYS

CLINICAL PATHOLOGY

ECG



**MAHMOUD SEWILAM**

KASR AL-AINY SCHOOL OF MEDICINE  
CAIRO UNIVERSITY

SECOND  
EDITION

VISIT...

LANZAROTE  
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## X-Rays

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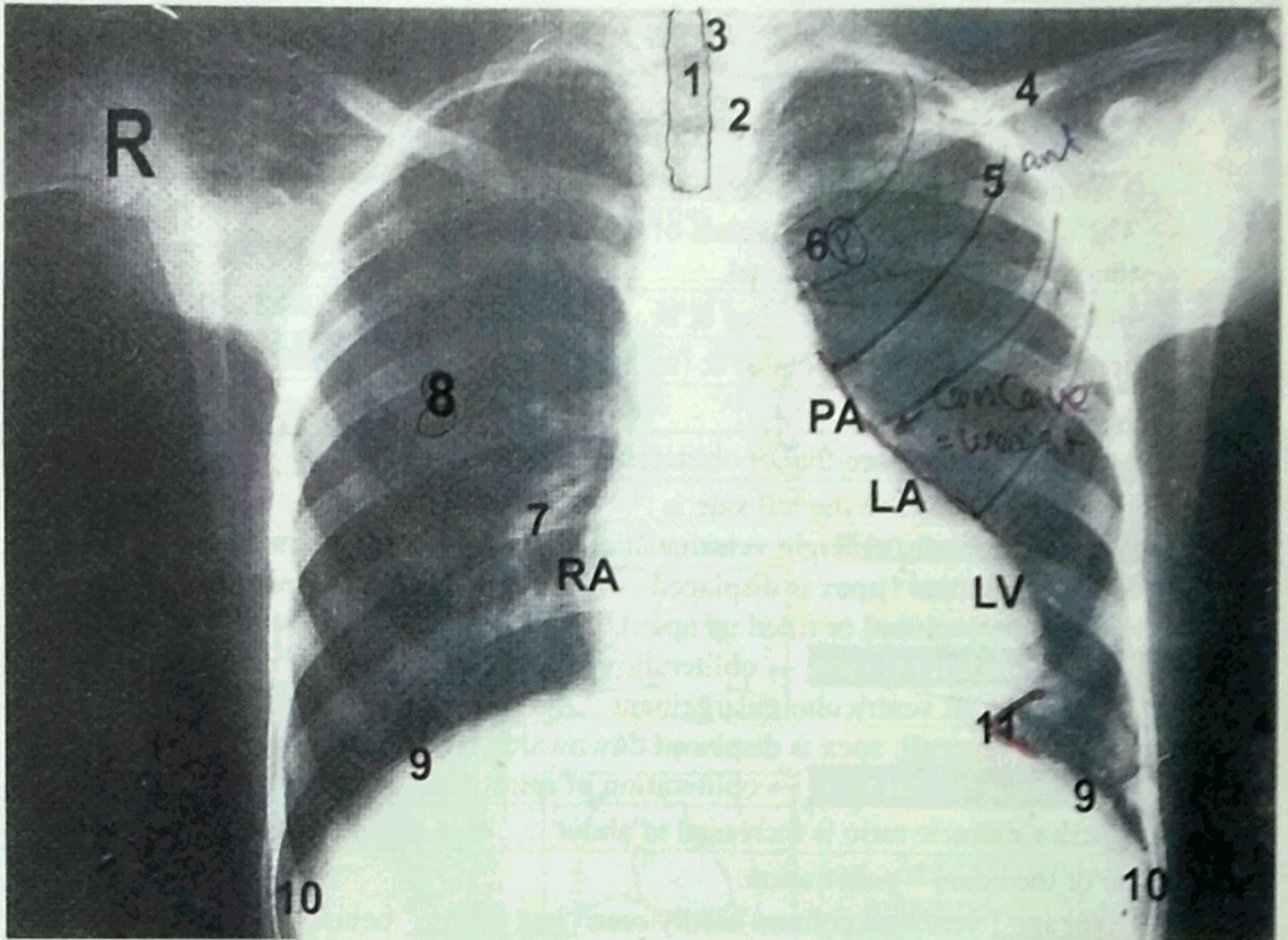
# X-Rays

1. Frontal view of skull
2. Vertex view
3. Spinos process of the vertebrae
4. Cervical
5. Anterior view
6. Posterior view
7. Brachiocephalic view
8. Lateral view
9. Thoracic view
10. Cervical view
11. Cervical view
12. RA : right anterior
13. PA : posterior
14. LA : left anterior
15. LV : left ventricle

التيه يرحون بالدموع يحدود بالابتهاج  
انظروا إلى الأجيال القديمة وتأملوا. هل توكّل أحد على الرب فنجّي؟  
الذي بدأ معك أول الطريق له يترك في منتصفه  
هو شافى هو عارف مش ينسى ☺

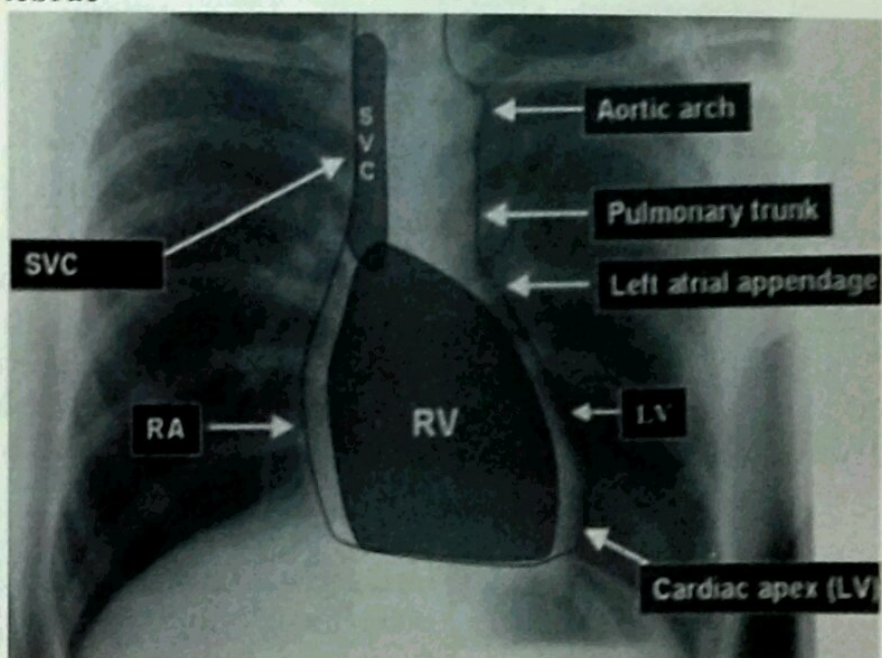


## Normal heart X-ray



1. Tracheal air column
2. Vertebral column
3. Spinous processes of the vertebrae
4. Clavicles
5. Anterior ribs
6. Posterior ribs
7. Bronchovascular markings
8. Lung fields
9. Diaphragmatic cupulae
10. Costophrenic angles
11. Cardiophrenic angle

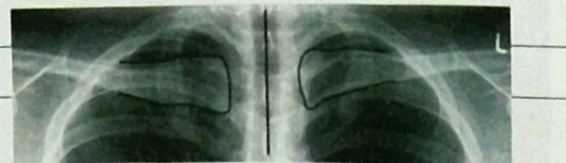
- RA : right atrium
- PA : pulmonary artery
- LA : left atrium
- LV : left ventricle



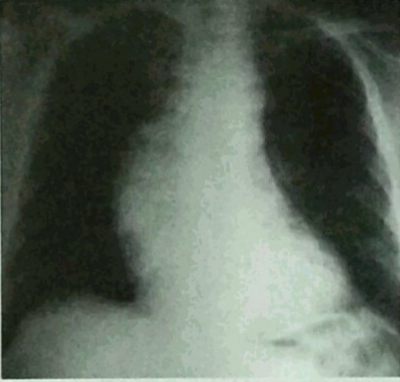
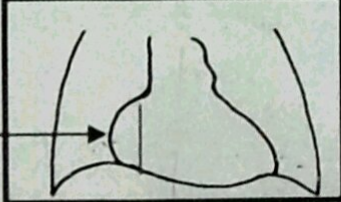
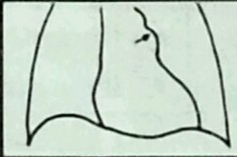
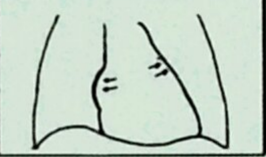
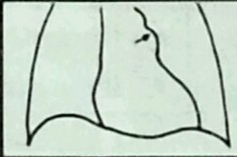
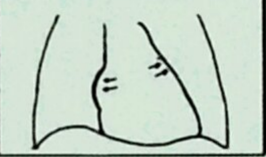
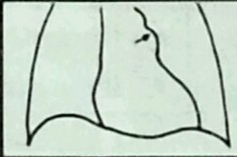
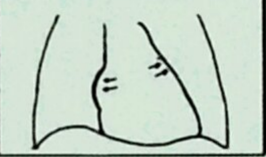


## Heart – X-Ray

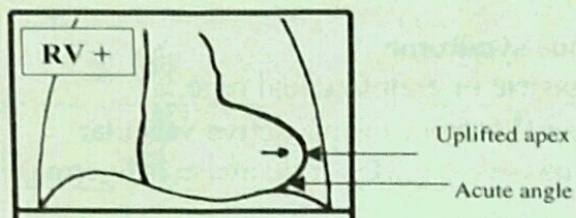
❖ How to comment on heart X-ray:

|          |                                                                                                                                                                                                                         |                                                                                    |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>P</b> | <b>P</b> lain X-ray chest & heart.                                                                                                                                                                                      |  |
|          | <b>P</b> osteroanterior view or lateral view                                                                                                                                                                            |                                                                                    |
|          | <b>P</b> atient is centralized or not                                                                                                                                                                                   |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- Two clavicles are in the same level</li> <li>- The distances of the medial ends of both clavicles to midline (line passing through the vertebral spines) are equal.</li> </ul> |                                                                                    |
|          | <b>P</b> osition of mediastinum (trachea & heart) central or shifted.                                                                                                                                                   |                                                                                    |
|          | <b>P</b> atient gender is (adult or child) & (male or female → breast shadow)                                                                                                                                           |                                                                                    |
|          | <b>B</b> ony cage is intact                                                                                                                                                                                             |                                                                                    |
| <b>C</b> | <b>C</b> ostophrenic angles are free or obliterated on both sides                                                                                                                                                       |                                                                                    |
|          | <b>C</b> ardiophrenic angle in the left side is :                                                                                                                                                                       |                                                                                    |
|          | ❖ <b>Acute</b> : normally or Right ventricular enlargement ( $\pm$ cor-pulmonale)                                                                                                                                       |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- RV enlargement : apex is displaced outwards and becomes separated from the diaphragm (uplifted or tilted up apex).</li> </ul>                                                  |                                                                                    |
|          | <b>NB : RVE on lateral view</b> → obliteration of retro-sternal space                                                                                                                                                   |                                                                                    |
|          | ❖ <b>Obtuse</b> : Left ventricular enlargement                                                                                                                                                                          |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- LV enlargement : apex is displaced downwards &amp; outwards. (dipping down apex)</li> </ul>                                                                                    |                                                                                    |
|          | <b>NB : LVE on lateral view</b> → obliteration of retro-cardiac space                                                                                                                                                   |                                                                                    |
|          | ❖ <b>C</b> ardio-thoracic ratio is increased to about ..... % which denotes cardiomegaly.                                                                                                                               |                                                                                    |
| <b>D</b> | <b>D</b> ose of the beam = penetration:                                                                                                                                                                                 |                                                                                    |
|          | • <b>Average</b> : vertebral column hardly seen “just visible” behind the heart                                                                                                                                         |                                                                                    |
|          | • <b>Overdose (hard X-Ray)</b> : vertebral column <u>well seen</u> behind the heart                                                                                                                                     |                                                                                    |
|          | • <b>Under dose (soft X-Ray)</b> : vertebral column <u>not seen</u> behind the heart                                                                                                                                    |                                                                                    |
|          | <b>D</b> iaphragm :                                                                                                                                                                                                     |                                                                                    |
|          | ❖ Cuts the 6 <sup>th</sup> rib anteriorly , 10 <sup>th</sup> posteriorly                                                                                                                                                |                                                                                    |
|          | ❖ Copula :                                                                                                                                                                                                              |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- Right copula is higher than left copula</li> </ul>                                                                                                                             |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- Dome in shape “smooth &amp; convex upwards” ,</li> </ul>                                                                                                                       |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- Not elevated, Not depressed by any diseases.</li> </ul>                                                                                                                        |                                                                                    |
|          | <b>D</b> etails :                                                                                                                                                                                                       |                                                                                    |
|          | 1. <b>Calcifications</b> around the pericardium of the heart → <b>constrictive pericarditis</b>                                                                                                                         |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- Decrease cardio-thoracic ratio</li> </ul>                                                                                                                                      |                                                                                    |
|          | <ul style="list-style-type: none"> <li>- Most common cause is TB ; maybe there is evidence of TB lung as heterogeneous opacity and compensatory emphysema in the lung.</li> </ul>                                       |                                                                                    |
|          | 2. <b>Type of valves</b> = radiopaque rings ( Edge & ball – tilting disc – bileaflets )                                                                                                                                 |                                                                                    |
|          |                                                                                                                                                                                                                         |                                                                                    |
|          |                                                                                                                                                                                                                         |                                                                                    |
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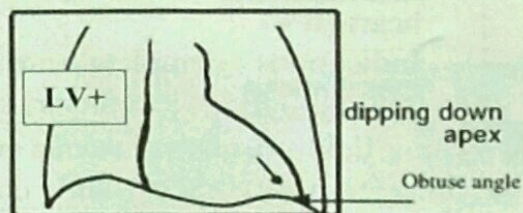


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| <p>4. <b>Pacemaker</b> ; the battery is subcutaneous and electrodes are passing inside the heart (RV)</p> <p>- Indications : complete heart block &amp; sick sinus syndrome.</p> <p>5. <b>Catheters</b> : CVP catheter, chest tube, Nasogastric or endotracheal tube.</p>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                                                                                                                                                                                    |                                                                                                                      |                                                                                                                |                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                    |  |                                  |                                                                                                                                                                                                     |                            |                                                                 |
| <p><b>L</b> <b>Lung field</b> : Bronchovascular markings , increase (Plethora means active vascular congestion e.g. ASD – while congestion means passive e.g. MS) or decrease (oligemia)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                                                                                                                                                                                    |                                                                                                                      |                                                                                                                |                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                    |  |                                  |                                                                                                                                                                                                     |                            |                                                                 |
| <p><b>L</b> <b>Left cardiac border &amp; right cardiac border</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                                                                                                                                                                                    |                                                                                                                      |                                                                                                                |                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                    |  |                                  |                                                                                                                                                                                                     |                            |                                                                 |
| <p><b>Right cardiac border</b></p> <p>- <b>Upper part represent: SVC &amp; ascending aorta.</b></p> <p>➤ <b>Bulging in the Upper part of the border :</b></p> <p>→ dilated ascending aorta</p> <p>❖ Causes : aortic stenosis with post-stenotic dilatation &amp; aneurysm of ascending aorta .</p>  <p>- <b>Lower part represents RA.</b></p> <p>➤ <b>Bulging in the Lower part of the border</b></p> <p>→ right atrium enlargement</p> <p>❖ Causes Tricuspid valve disease (TR) &amp; mitral valve disease )</p>  | <p><b>Left cardiac border</b></p> <table border="1"> <tr> <td data-bbox="593 470 920 728"> <p><b>1<sup>st</sup> space</b></p>  </td><td data-bbox="920 470 1455 728"> <p><b>Represent : Aortic knuckle = Aortic arch</b></p> <p>→ prominent aortic knuckle in the first space = aneurysm of aortic arch</p> <p>Presents as wide superior mediastinum</p> </td></tr> <tr> <td data-bbox="593 728 920 952"> <p><b>2<sup>nd</sup> space</b></p>  </td><td data-bbox="920 728 1455 952"> <p><b>Represent : Pulmonary artery</b></p> <p>→ prominent pulmonary conus → = pulmonary dilatation (P.HTN)</p> </td></tr> <tr> <td data-bbox="593 952 920 1467"> <p><b>3<sup>rd</sup> space</b></p>  </td><td data-bbox="920 952 1455 1467"> <p><b>Represent : Left atrium</b></p> <p><b>Left atrium enlargement evidence by :</b></p> <p>→ <b>شمال</b> : obliteration of the waist = mitralization (Mitral valve disease most probably MS)</p> <p>→ <b>يمين</b> : double contour of the RT cardiac border</p> <p>❖ <b>On lateral view with barium swallow</b> LA enlargement =</p> <p>- Backward displacement (± indentation) of the esophagus.</p> </td></tr> <tr> <td colspan="2" data-bbox="593 1467 1455 1579"> <p>• <b>Waist of the heart is a concavity on the left cardiac border opposite 2<sup>nd</sup> and 3<sup>rd</sup> space ( formed by normal contour of the pulmonary artery and left auricle.</b></p> </td></tr> <tr> <td data-bbox="593 1579 920 1825"> <p><b>3<sup>rd</sup> rib</b></p> </td><td data-bbox="920 1579 1455 1825"> <p>Normally aorta folded upon itself,</p> <p><b>Abnormally</b> : unfolding of aorta in front 3<sup>rd</sup> rib = dilated aorta</p> <p>- Systemic HTN</p> <p>- Atherosclerosis</p> <p>- Old age</p> </td></tr> <tr> <td data-bbox="593 1825 920 1915"> <p><b>Angle = Apex</b></p> </td><td data-bbox="920 1825 1455 1915"> <p><b>Cardiophrenic angle</b> in the left side ; see before</p> </td></tr> </table> | <p><b>1<sup>st</sup> space</b></p>  | <p><b>Represent : Aortic knuckle = Aortic arch</b></p> <p>→ prominent aortic knuckle in the first space = aneurysm of aortic arch</p> <p>Presents as wide superior mediastinum</p> | <p><b>2<sup>nd</sup> space</b></p>  | <p><b>Represent : Pulmonary artery</b></p> <p>→ prominent pulmonary conus → = pulmonary dilatation (P.HTN)</p> | <p><b>3<sup>rd</sup> space</b></p>  | <p><b>Represent : Left atrium</b></p> <p><b>Left atrium enlargement evidence by :</b></p> <p>→ <b>شمال</b> : obliteration of the waist = mitralization (Mitral valve disease most probably MS)</p> <p>→ <b>يمين</b> : double contour of the RT cardiac border</p> <p>❖ <b>On lateral view with barium swallow</b> LA enlargement =</p> <p>- Backward displacement (± indentation) of the esophagus.</p> | <p>• <b>Waist of the heart is a concavity on the left cardiac border opposite 2<sup>nd</sup> and 3<sup>rd</sup> space ( formed by normal contour of the pulmonary artery and left auricle.</b></p> |  | <p><b>3<sup>rd</sup> rib</b></p> | <p>Normally aorta folded upon itself,</p> <p><b>Abnormally</b> : unfolding of aorta in front 3<sup>rd</sup> rib = dilated aorta</p> <p>- Systemic HTN</p> <p>- Atherosclerosis</p> <p>- Old age</p> | <p><b>Angle = Apex</b></p> | <p><b>Cardiophrenic angle</b> in the left side ; see before</p> |
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| <p><b>Angle = Apex</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p><b>Cardiophrenic angle</b> in the left side ; see before</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                                                                                                                                                                                    |                                                                                                                      |                                                                                                                |                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                    |  |                                  |                                                                                                                                                                                                     |                            |                                                                 |
| <p><b>Gross cardiomegaly</b> : asymmetrical enlargement , borders not well defined , increase bronchovascular markings = <b>without characteristic shape</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                                                                                                                                                                                    |                                                                                                                      |                                                                                                                |                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                    |  |                                  |                                                                                                                                                                                                     |                            |                                                                 |
| <p><b>Diagnosis :</b></p> <p><b>Gross cardiomegaly “cor bovinum”</b> due to enlargement of ...&amp;... for differential diagnosis , most probably due to ...</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                                                                                                                                                                                    |                                                                                                                      |                                                                                                                |                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                    |  |                                  |                                                                                                                                                                                                     |                            |                                                                 |

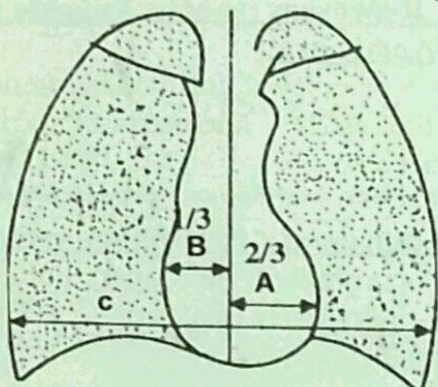




### ❖ Apex:

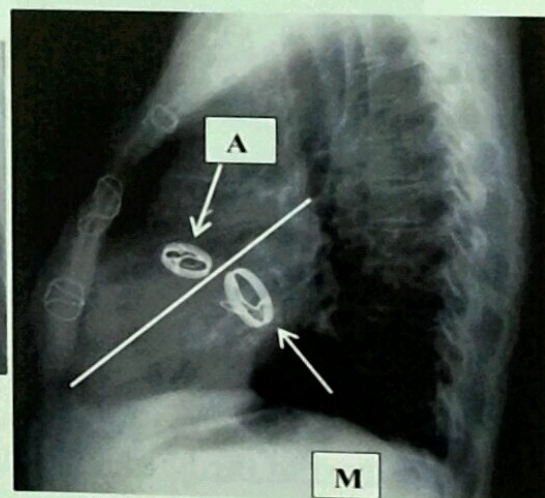
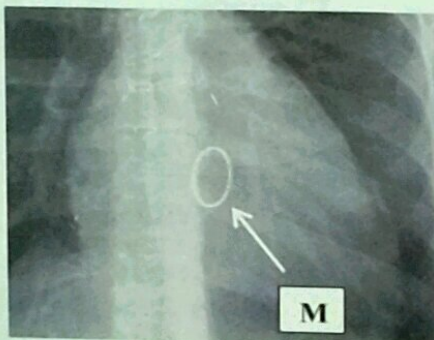
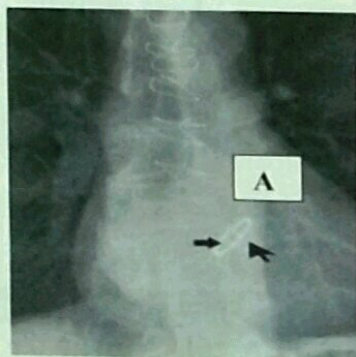


### ❖ Cardiothoracic ratio:



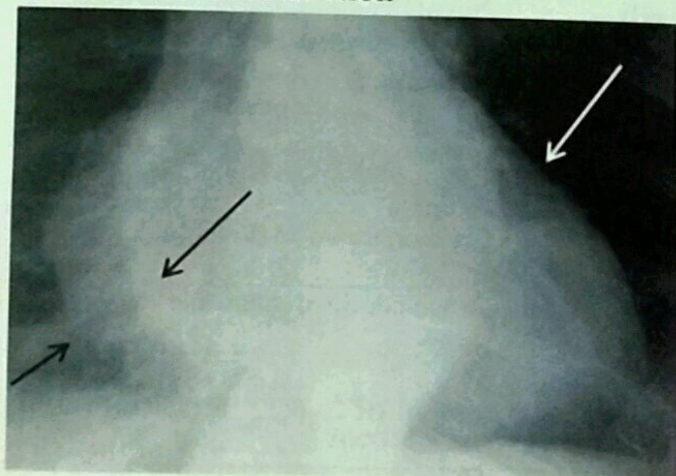
- A : point from midline to maximum point in the left cardiac border, normally = 2/3 of the heart
- B: point from midline to maximum point in the right cardiac border, normally = 1/3 of the heart
- A+B = maximum width of the cardiac shadow
- C = the maximum chest width
- Normally :  $(A+B) \div C = < \frac{1}{2}$
- if the ratio is more than 1/2 = cardiomegaly

### Valves:



### ❖ Signs of LA enlargement :

- ❖ Double contour of the RT cardiac border & mitralization

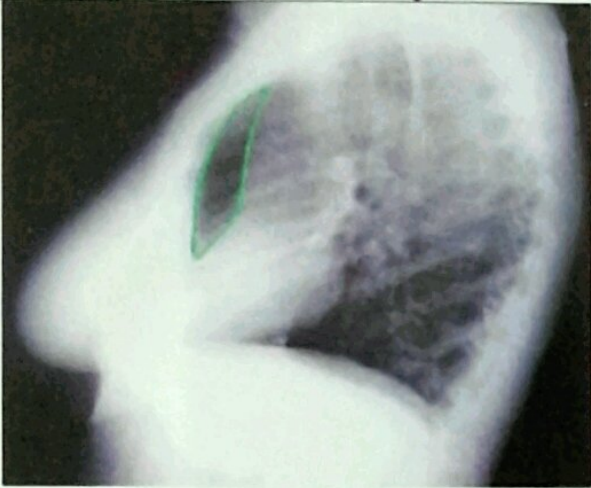
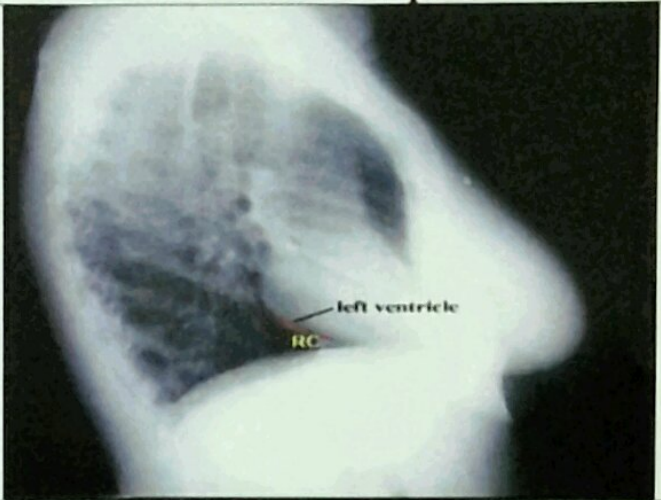
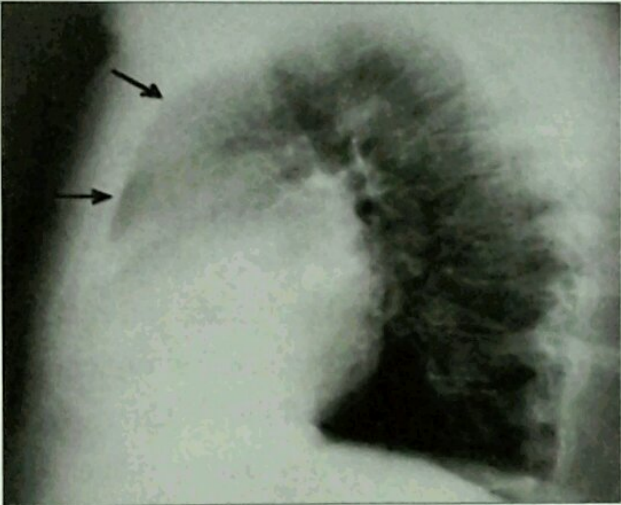
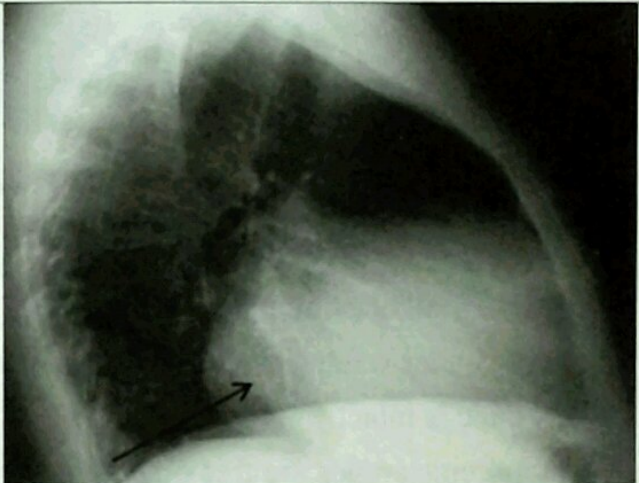


Backward displacement ( $\pm$  indentation) of the esophagus. (lateral view)

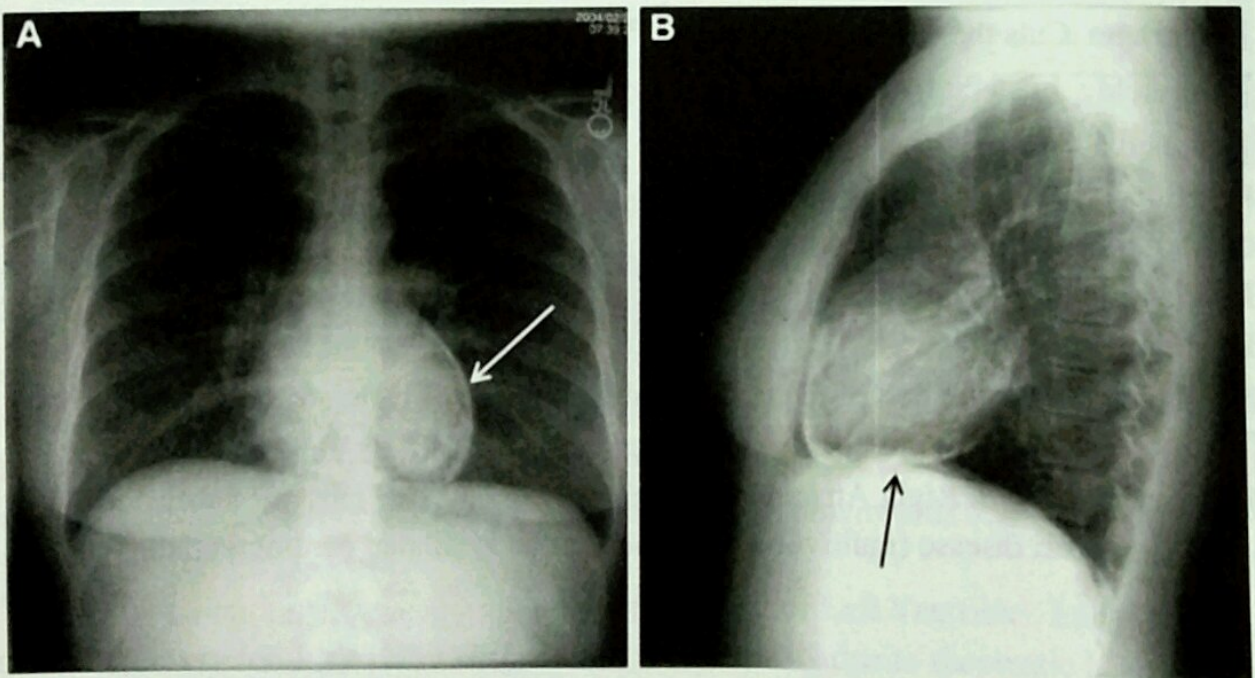




❖ Spaces on the lateral view :

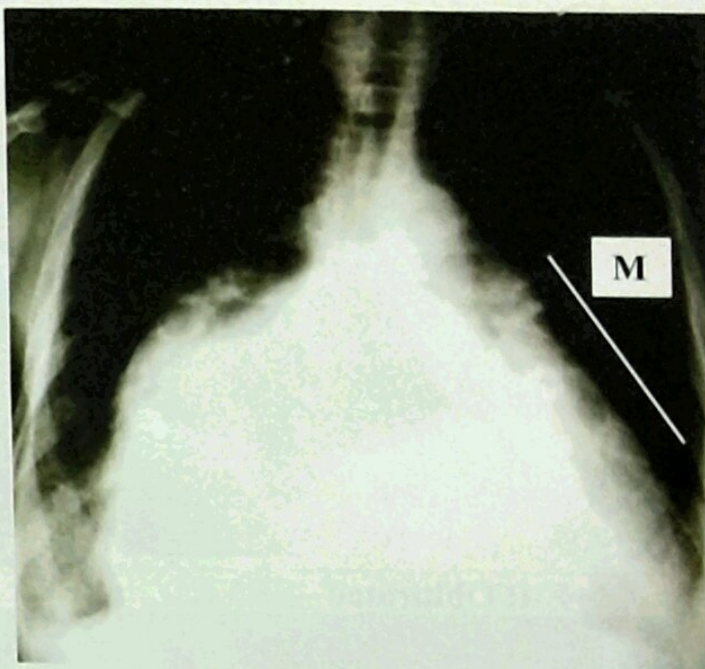
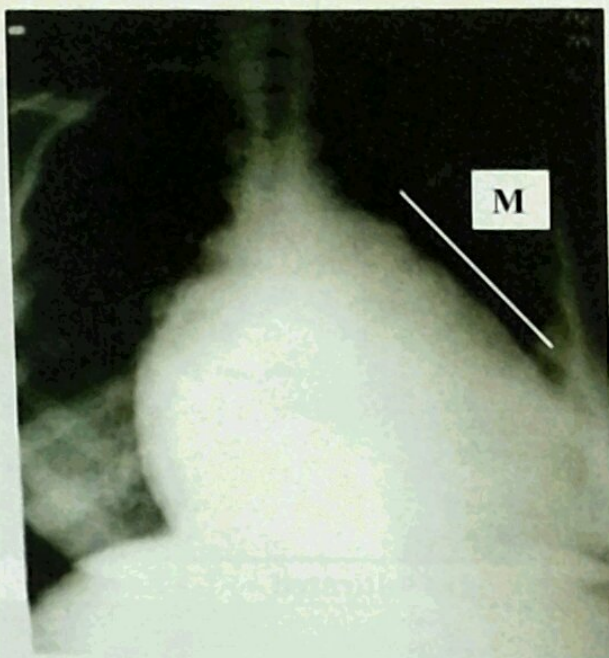
| Retrosternal space                                                                 | Retrocardiac space                                                                  |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|    |   |
| ❖ If Obliterated → RVE                                                             | If Obliterated → LVE                                                                |
|  |  |

❖ Constrictive pericarditis





## Cardiomegaly WITHOUT characteristic shape

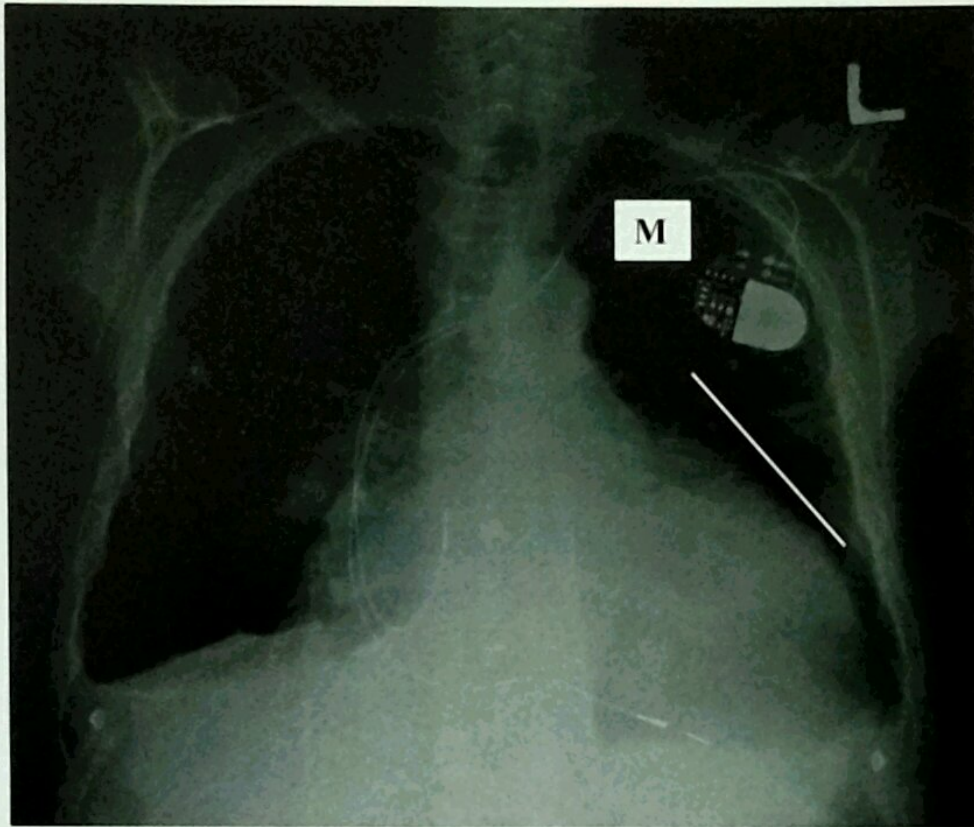


M

• MITRALIZED HEART : LA +

- Plain X-ray chest & heart.
- Posteroanterior view
- Patient is not centralized
- Position of mediastinum (trachea & heart) is central
- Patient gender is adult female (breast shadow)
- Bony cage is intact
- Costophrenic angles are free on both sides
- Cardiophrenic angle in the left side is obtuse → LV enlargement
- Cardio-thoracic ratio is increased to about 70 % which denotes cardiomegaly.
- Diaphragm : Cuts the 6<sup>th</sup> rib anteriorly , 10<sup>th</sup> posteriorly
- Lung field : bilateral increase in Bronchovascular markings
- Left cardiac border :
  - Prominent pulmonary conus → pulmonary dilatation (P.HTN)
  - Obliteration of the waist = mitralization → LA enlargement
  - Bulging left cardiac border with dipping down & shifted downwards & outwards apex → LV enlargement
- Bulging in the Lower part of the right cardiac border → right atrium enlargement
- ❖ **Diagnosis : Gross cardiomegaly** : due to enlargement of Left Ventricle , Left Atrium , Pulmonary artery & Right Atrium for differential diagnosis , most probably due to rheumatic heart disease (multivulvar disease) or due to dilated cardiomyopathy





- **P**lain X-ray chest & heart.
- **P**osteroanterior view
- **P**atient is not centralized
- **P**osition of mediastinum (trachea & heart) is central
- **P**atient gender is adult male
- **B**ony cage is intact
- **C**ostophrenic angle is free on the right side , while in the left side is obliterated by homogeneous opacity with fluid level (concave upwards) rising lateral to axilla → mild pleural effusion.
- **C**ardiophrenic angle in the left side is obtuse → LV enlargement
- **C**ardio-thoracic ratio is increased to about 70 % which denotes cardiomegaly.
- **D**iaphragm :Cuts the 10<sup>th</sup> rib posteriorly
- **D**etails : Pacemaker ; the battery is subcutaneous and electrodes are passing inside the heart (RV)
- **L**ung field : bilateral increase in Bronchovascular markings
- **L**eft cardiac border :
  - Prominent pulmonary conus → pulmonary dilatation (P.HTN)
  - Obliteration of the waist = mitralization → LA enlargement
  - Bulging left cardiac border with dipping down & shifted downwards &outwards apex → LV enlargement
- ❖ **Diagnosis : Gross cardiomegaly** : due to enlargement of Left Ventricle , Left Atrium & Pulmonary artery for differential diagnosis , most probably due to rheumatic heart disease (multivulvar disease) or due to dilated cardiomyopathy





• **GLOBULAR HEART:**  
RA + , RV + & broad and wide cardiac base

- **P**lain X-ray chest & heart.
  - **P**osteroanterior view
  - **P**atient is not centralized
  - **P**osition of mediastinum (trachea & heart) is central
  - **P**atient gender is child (broadened spatulate ribs).
  - **B**ony cage is intact
  - **B**road & wide cardiac base. (NB: TGA has narrow base)
  - **C**ostophrenic angles are free on both sides
  - **C**ardiophrenic angle in the left side is acute → RV enlargement
  - **C**ardio-thoracic ratio is increased to about 70 % which denotes cardiomegaly.
  - **L**ung field : mild increase in Bronchovascular markings
  - **L**eft cardiac border : bulging left cardiac border with uplifted & shifted outwards apex → RV enlargement
  - Bulging in the **L**ower part of the **right cardiac border** → right atrium enlargement
- ❖ **Diagnosis : Gross cardiomegaly** : due to enlargement of right Ventricle & right Atrium for differential diagnosis , most probably due to metabolic diseases.





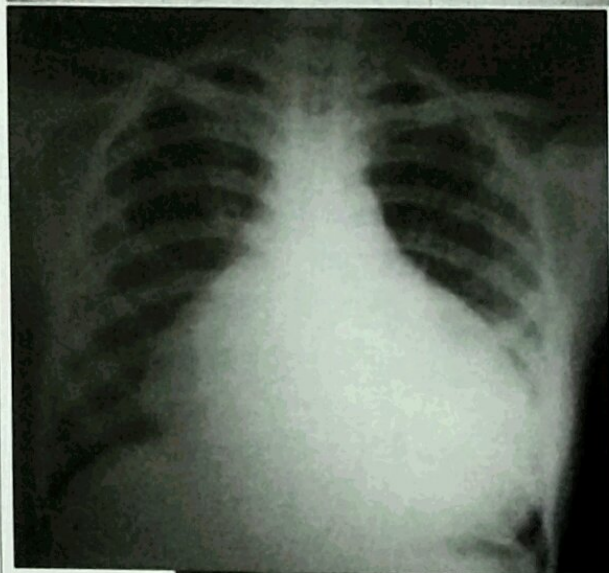
- **P**lain X-ray chest & heart.
- **P**osteroanterior view
- **P**atient is centralized
- **P**osition of mediastinum (trachea & heart) is central
- **P**atient gender is adult male
- **B**ony cage is intact
- **C**ostophrenic angles are free on both sides
- **C**ardiophrenic angle in the left side is acute → RV enlargement
- **C**ardio-thoracic ratio is increased to about 60 % which denotes cardiomegaly.
- **D**iaphragm :Cuts the 10<sup>th</sup> rib posteriorly
- **L**ung field :
  - Bilateral increase in Bronchovascular markings
  - Heterogenous opacity in the left upper lobe of the lung → Pneumonia
- **L**eft cardiac border :
  - Prominent pulmonary conus → pulmonary dilatation (P.HTN)
  - Obliteration of the waist = mitralization → LA enlargement
  - Bulging of left cardiac border with uplifted & shifted outwards apex → RV enlargement
- Double contour of the right cardiac border → LA enlargement
- ❖ **Diagnosis : Gross cardiomegaly** : due to enlargement of Right Ventricle , Left Atrium & Pulmonary artery for differential diagnosis , most probably due to rheumatic heart disease (multivulvar disease) or due to dilated cardiomyopathy



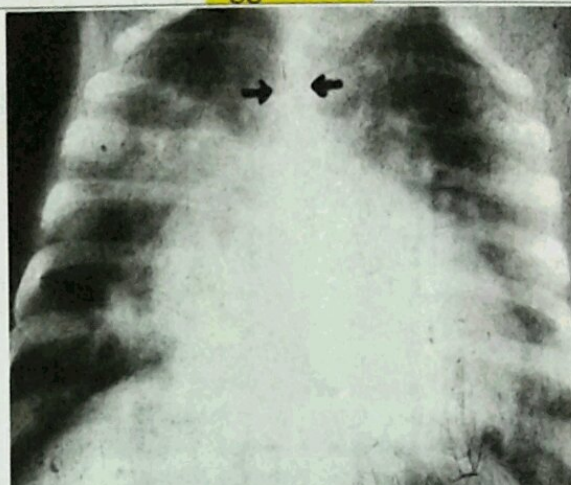
## Cardiomegaly WITH characteristic shape



**Flask shaped heart**



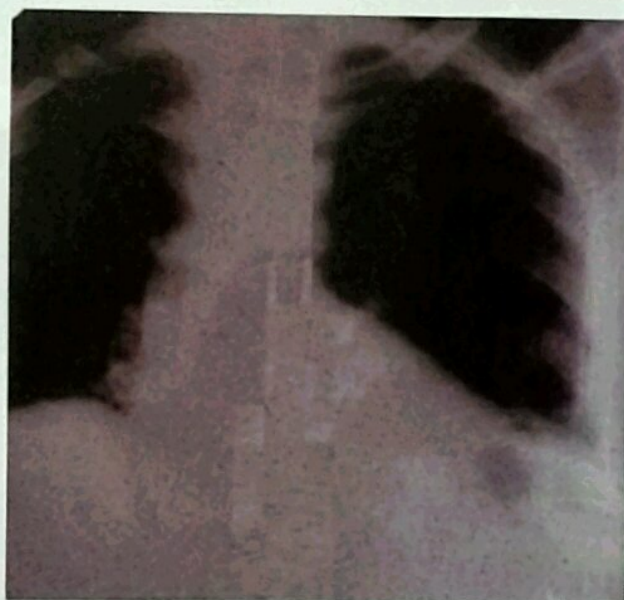
**Egg on side**



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>- Wide &amp; broad <b>cardiac base</b></li> <li>- Stenciled (very well defined) , smooth &amp; symmetrical bulging of <b>cardiac borders</b></li> <li>- <b>Cardiophrenic angle</b> on the left side is acute</li> <li>- <b>Lung oligemia</b> : decrease bronchovascular markings</li> <li>- <b>Radiological appearance</b> of the heart simulates a flask</li> <li>- If <b>complicated</b> pneumopericardium (area of jet black translucency surrounding the cardiac shadow)</li> </ul> | <ul style="list-style-type: none"> <li>- Narrow <b>cardiac base</b></li> <li>- Marked bulge of the right <b>cardiac border</b> (RA dilatation)</li> <li>- <b>Cardiophrenic angle</b> on the left side is acute (RV dilatation)</li> <li>- <b>Lung plethora</b> , Increase bronchovascular markings</li> <li>- <b>Radiological appearance</b> of the heart simulates egg on side</li> </ul> |
| <ul style="list-style-type: none"> <li>➤ <b>Diagnosis</b> : cardiomegaly for DD most probably due to pericardial effusion</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>➤ <b>Diagnosis</b> : cardiomegaly for DD most probably due to transposition of great arteries</li> </ul>                                                                                                                                                                                                                                            |

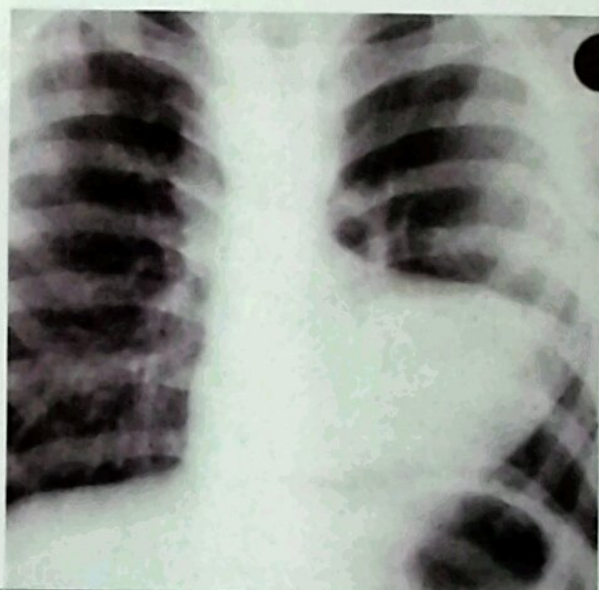


## Boot shaped heart "Aortic configuration"



- Plethoric lungs
  - Wide mediastinum
  - Dilated aorta
  - Preserved or exaggerated waist
  - Cardio-thoracic ratio is increased to about ..... % which denotes cardiomegaly.
  - Enlarged LV; obtuse cardiophrenic angle with dipping down apex
  - Radiological appearance of the heart simulates a boot.
- **Diagnosis :** cardiomegaly for DD, causes :
- Coarctation of aorta with Rosler's sign (notches in the lower parts of ribs due to dilated intercostal vessels)
  - Advanced systemic HTN , so it is called hypertensive heart disease
  - Aortic regurge

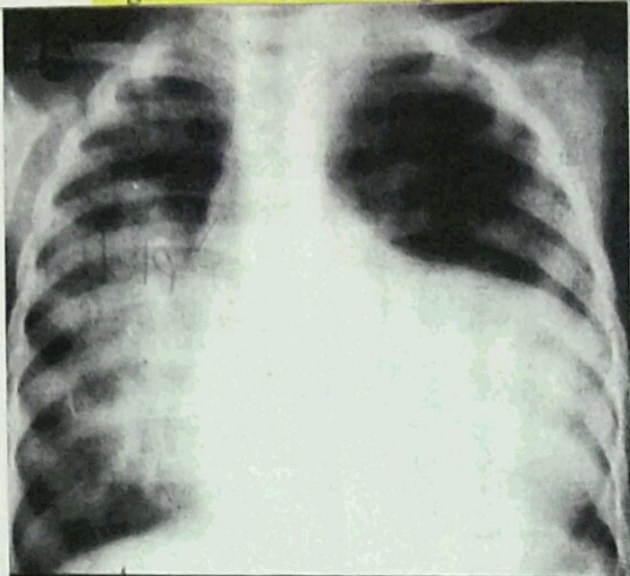
## Coeur en sabot in Fallot's tetralogy



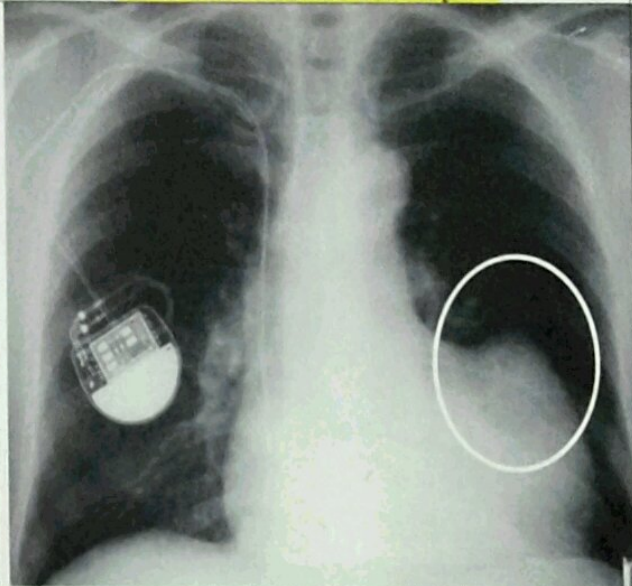
- Oligaemic lungs
  - Wide mediastinum
  - Dilated aorta
  - Exaggerated waist
  - Mild increase in Cardiothoracic ratio
  - Mild RV enlargement; acute cardiophrenic angle with tilted up apex
  - Radiological appearance of the heart simulates a wooden shoes with elevated tip.
- **Diagnosis :** Fallot's tetralogy :
- Pulmonary stenosis
  - Overriding aorta
  - VSD
  - Mild RV enlargement.



### Right ventricular enlargement

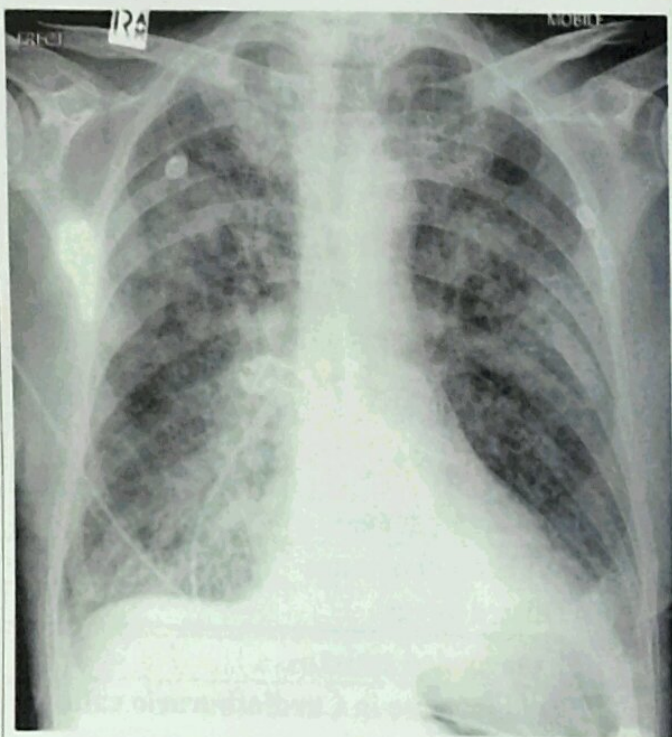


### Left ventricular aneurysm

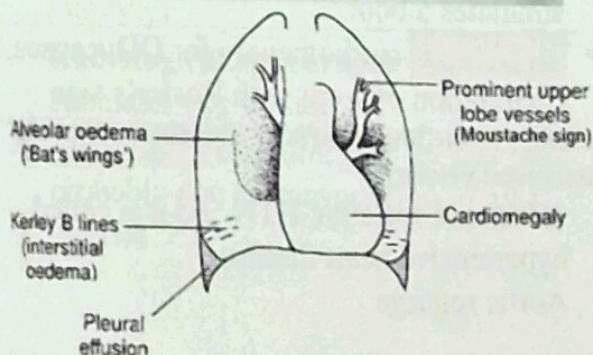


Increase cardiothoracic ratio with shouldering (shelfing) of the left cardiac border.

### Acute pulmonary edema

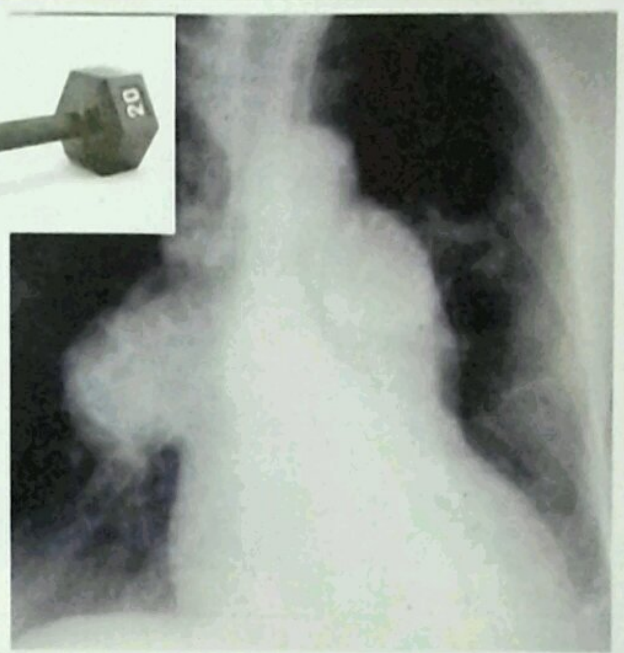
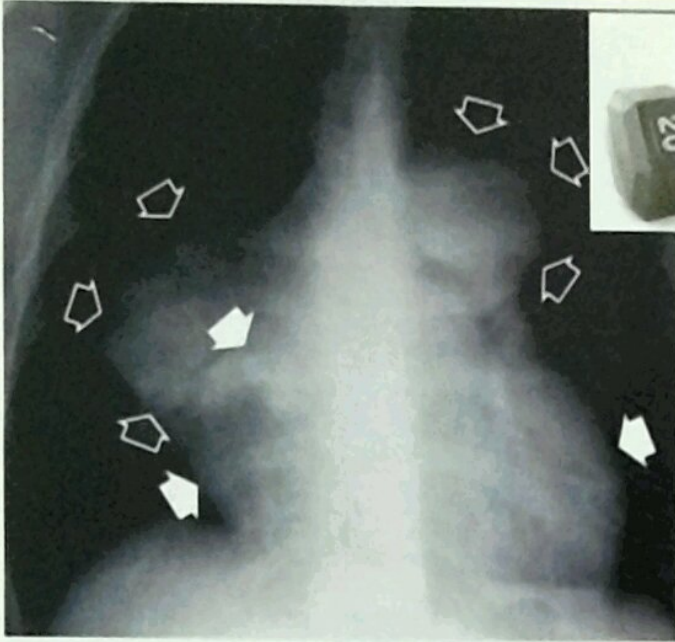


- **Haziness of lung fields**
- **Moustache sign** : pulmonary congestion : exaggerated pulmonary vascular markings especially in upper lung zones (prominent upper lobe vessels)
- **Kerley B lines** :  
- interstitial edema , basal , thin , short lines
- **± Bat's wing** : alveolar edema
- **± Cardiomegaly**
- **Pleural effusion.**



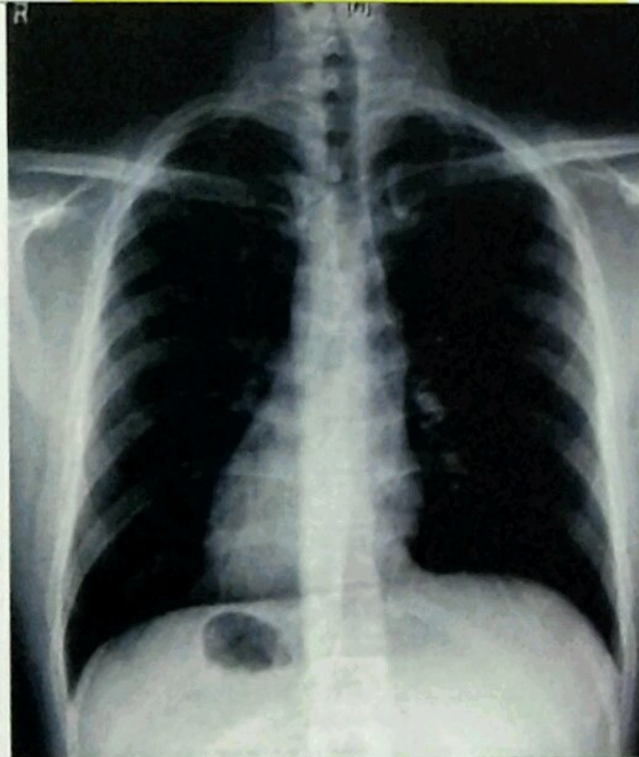


### Dumbbell shaped heart



- **Aneurysmal dilatation** of right and left pulmonary arteries as in primary pulmonary hypertension or bilharzial cor-pulmonale
- **Lung oligemia**
- **Radiological appearance** of the heart simulates a dumbbell.

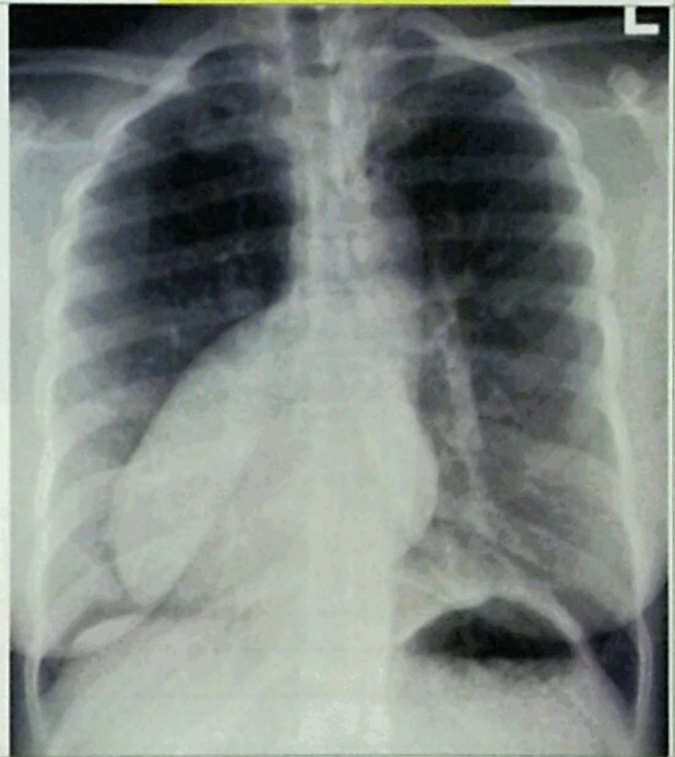
### Dextrocardia : situs inversus totalis



- **Heart** on right side of thorax mainly and apex pointing to the right .
- **Right cardiac border** is composed of pulmonary artery , left atrium & left ventricle
- **Left cardiac border** is composed of right atrium

- **Abdominal viscera** : gastric air bubble on the right side & liver shadow on the left side.

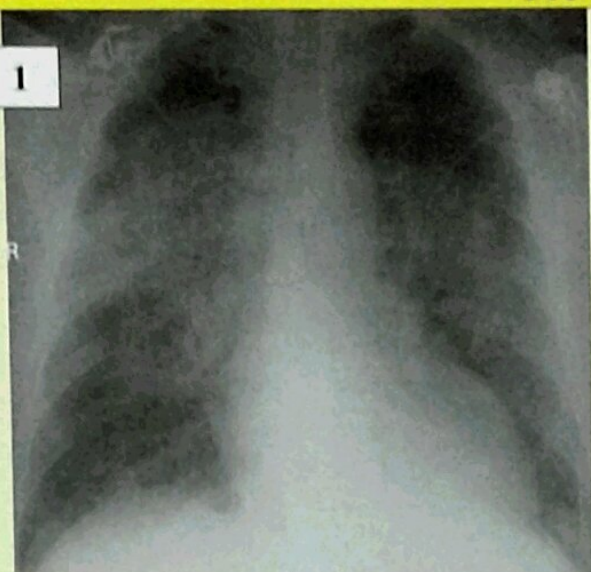
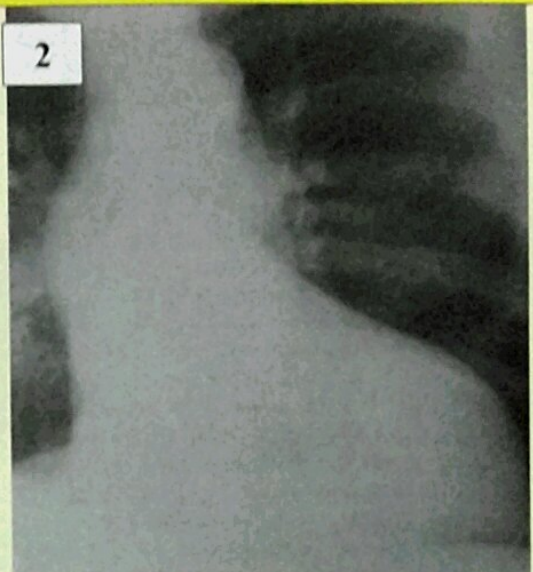
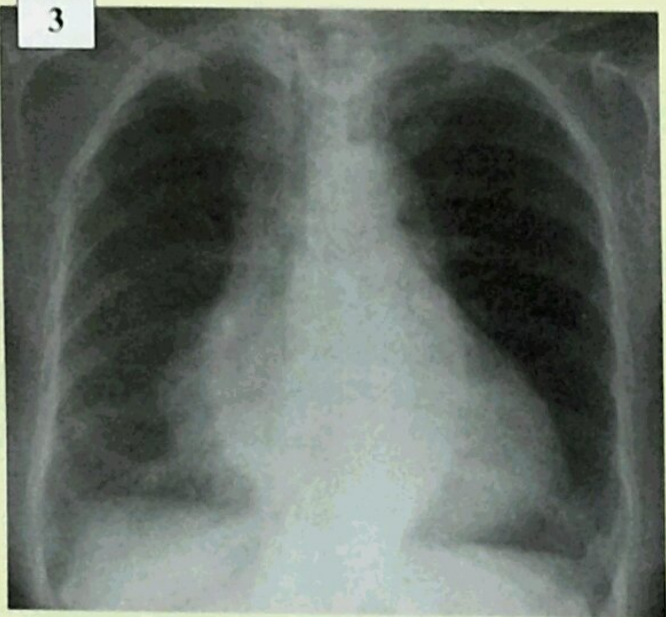
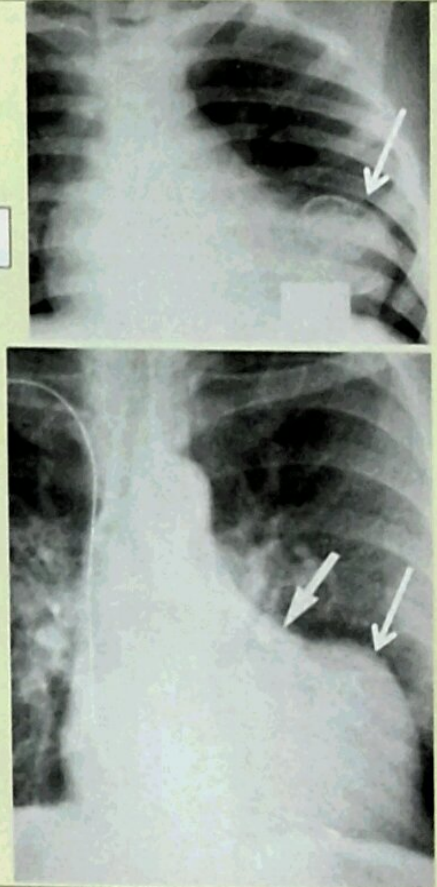
### Dextrocardia : isolated



- **Abdominal viscera** : in normal position , gastric air bubble on the left side & liver shadow on the right side.

- **NB: Dextroposition** : cardiac displacement due to lung pathology.

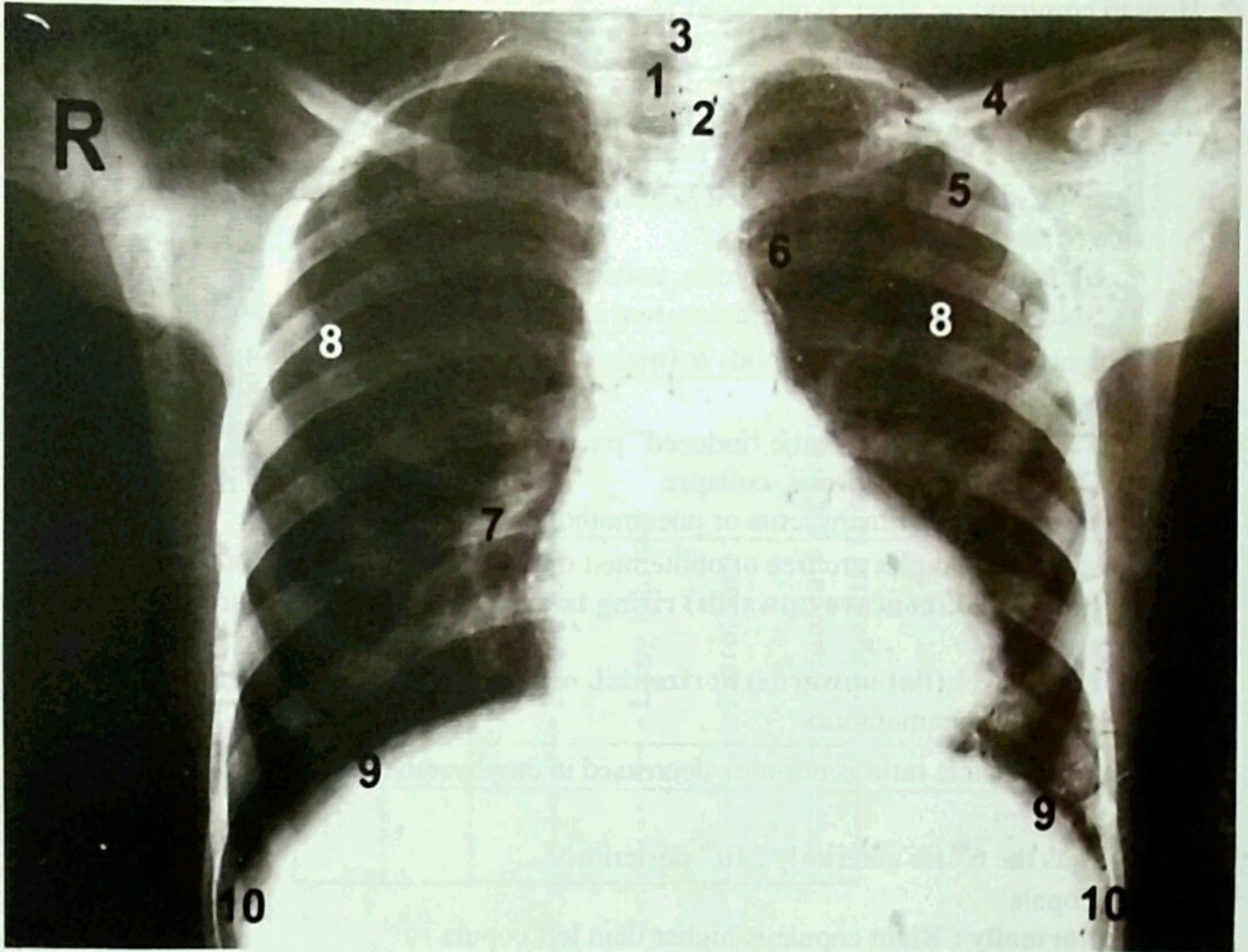


| Pre-test                                                                                    |                                                                                              |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| <p>1</p>   | <p>2</p>   |
| <p>• Diagnosis :</p>                                                                        | <p>•</p>                                                                                     |
| <p>3</p>  | <p>4</p>  |
| <p>• Diagnosis :</p>                                                                        | <p>•</p>                                                                                     |

| Answers                                                                                                          |
|------------------------------------------------------------------------------------------------------------------|
| 1) Acute pulmonary edema                                                                                         |
| 2) Boot shaped heart: aortic configuration                                                                       |
| 3) Gross cardiomegaly for differential diagnosis due to rheumatic heart disease or due to dilated cardiomyopathy |
| 4) Left ventricular aneurysm                                                                                     |



### Normal Chest – X-Ray



1. Tracheal air column
2. Vertebral column
3. Spinous processes of vertebrae
4. Clavicles
5. Anterior ribs
6. Posterior ribs
7. Bronchovascular markings
8. Lung fields
9. Diaphragmatic copulae
10. Costophrenic angles

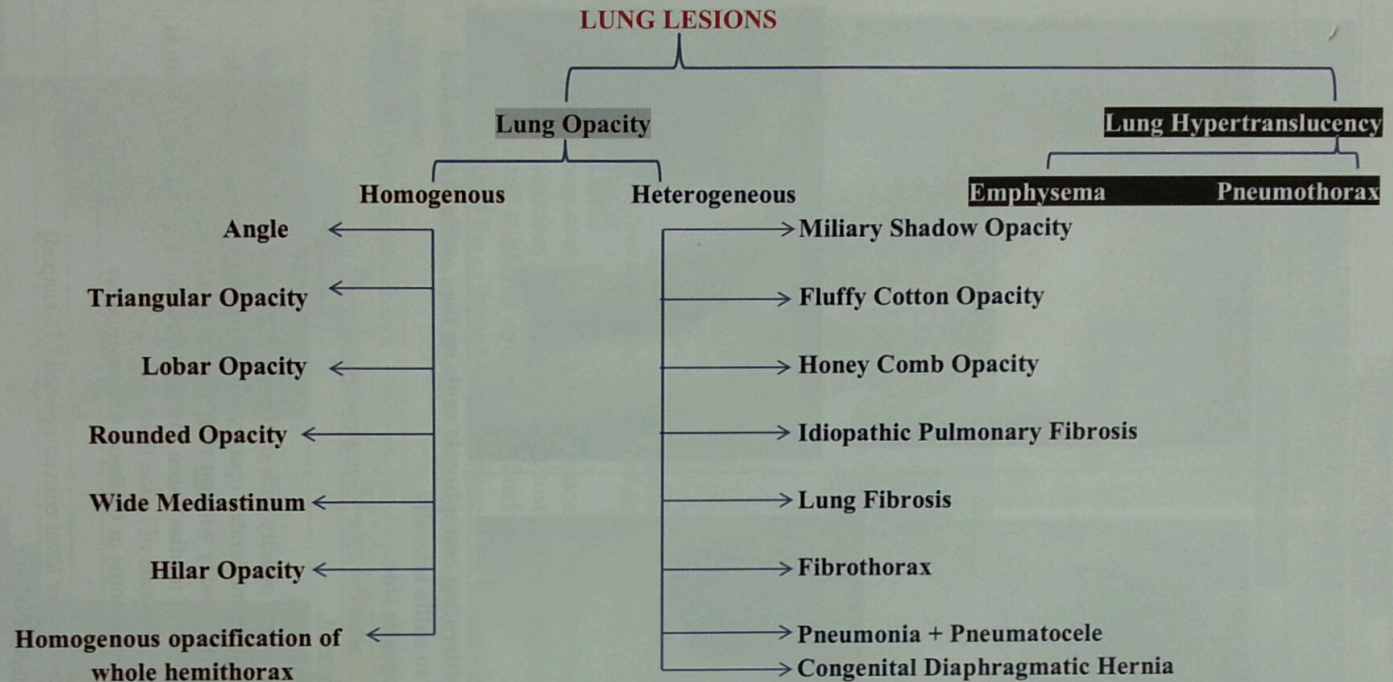


## Chest – X-Ray

❖ How to comment on chest X-ray:

|          |                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>P</b> | <b>P</b> lain X-ray chest & heart.                                                                                                                                                                                                                                                                                                                                                 |
|          | <b>P</b> osteroanterior view or lateral view                                                                                                                                                                                                                                                                                                                                       |
|          | <b>P</b> atient is centralized or not : see heart X-ray                                                                                                                                                                                                                                                                                                                            |
|          | <b>P</b> osition of mediastinum (trachea & heart) central or shifted to ... side which is ... side of the lesion.<br>- <b>Shift to the same side</b> : fibrosis, collapse<br>- <b>Shift to opposite side</b> : effusion, tension pneumothorax , hydropneumothorax.                                                                                                                 |
|          | <b>P</b> atient gender is (adult or child) & (male or female→ breast shadow)                                                                                                                                                                                                                                                                                                       |
|          | <b>B</b> ony cage = ribs :<br>- <b>Fractured rib</b> : traumatic ‘induced” pneumothorax<br>- <b>Crowded ribs</b> : fibrosis, collapse<br>- <b>Wide spaces</b> : emphysema or pneumothorax                                                                                                                                                                                          |
| <b>C</b> | <b>C</b> ostophrenic angles are free or obliterated on ..... side by homogenous opacity with:<br>- <b>Fluid level;(concave upwards) rising laterally to axilla</b> → in case of pleural effusion<br>- <b>Fluid level;(flat upwards) horizontal, occupying the ..... hemithorax</b> → in case of hydropneumothorax                                                                  |
|          | <b>C</b> ardio-thoracic ratio is normal , decreased in emphysema or can't be assessed                                                                                                                                                                                                                                                                                              |
| <b>D</b> | <b>D</b> iaphragm :<br>• Cuts the 6 <sup>th</sup> rib anteriorly , 10 <sup>th</sup> posteriorly<br>• Copula :<br>- <b>Normally</b> : Right copula is higher than left copula<br>- <b>Normally</b> : Dome in shape “smooth & convex upwards ” ,<br>- <b>Abnormally</b> : Elevated (tenting) by fibrosis or collapse, or depressed by emphysema , pneumothorax or hydropneumothorax. |
|          | <b>D</b> etails :<br>* <b>Catheters</b> : CVP catheter, chest tube, Nasogastric or endotracheal tube.                                                                                                                                                                                                                                                                              |
| <b>L</b> | <b>L</b> ung field : Bronchovascular markings ,<br>- <b>Increase</b> in emphysema<br>- <b>Decrease</b> or absent in pneumothorax                                                                                                                                                                                                                                                   |
| <b>S</b> | <b>S</b> ite :<br>- <b>Lobes</b> :<br>• Right lung : superior lobe , middle lobe & inferior lobe<br>• Left lung : superior lobe & inferior lobe .<br>- <b>Laterality</b> : Unilateral : Right or left side, or Bilateral .<br>- <b>Zones</b> : upper(1,2 space) , middle (3,4), lower (5,6)                                                                                        |
|          | <b>S</b> ize : small , large or 3x 3 cm ... etc.                                                                                                                                                                                                                                                                                                                                   |
|          | <b>S</b> hape : rounded , triangular, fluffy cotton , ... etc.                                                                                                                                                                                                                                                                                                                     |
|          | <b>S</b> hadow : homogenous or heterogenous opacity                                                                                                                                                                                                                                                                                                                                |
|          | <b>S</b> everity : mild , moderate , massive (all hemoithorax)                                                                                                                                                                                                                                                                                                                     |





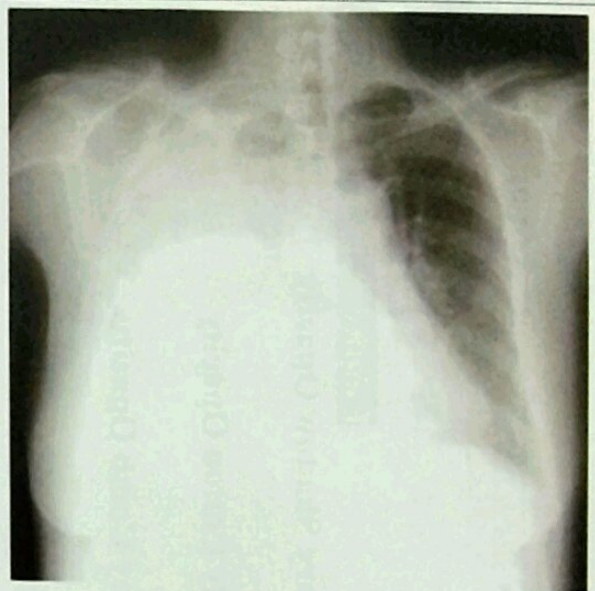
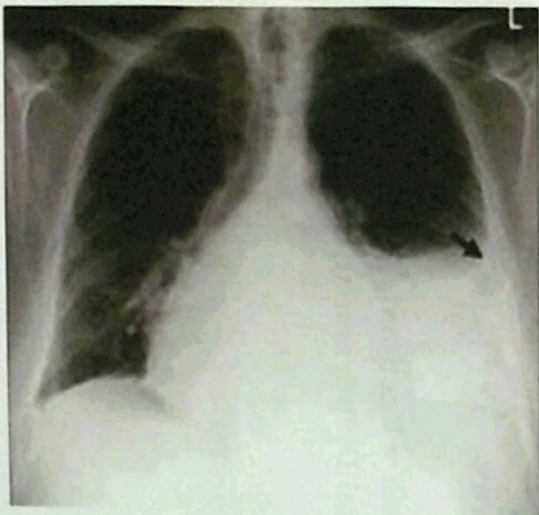


## ❖ Lung opacity

### I- Homogenous :

#### A-Angle :

#### 1- Pleural effusion



❖ Homogenous opacity obliterating costophrenic angle on the ... side & rising fluid level (concave upwards) to axilla laterally

❖  $\pm$  Mediastinal shift to opposite side.

• **NB :**

- Intercostal tube may be present.
- Amount according to fluid level :
  - 2<sup>nd</sup> rib : **massive effusion**; large opacity with shift of apex & trachea to opposite side
  - 2<sup>nd</sup> → 4<sup>th</sup> : **moderate effusion**; moderated opacity with shift of **apex** to opposite side
  - 4<sup>th</sup> rib : **mild effusion** ; small opacity with **no** shift of apex or trachea
- **Pleural effusion causing shift of mediastinum to opposite side** of the lesion, if there is shift of mediastinum to the same side of lesion think in :
  - Underlying fibrosis (heterogenous) or Collapse ( homogenous)

**Diagnosis :** Pleural effusion

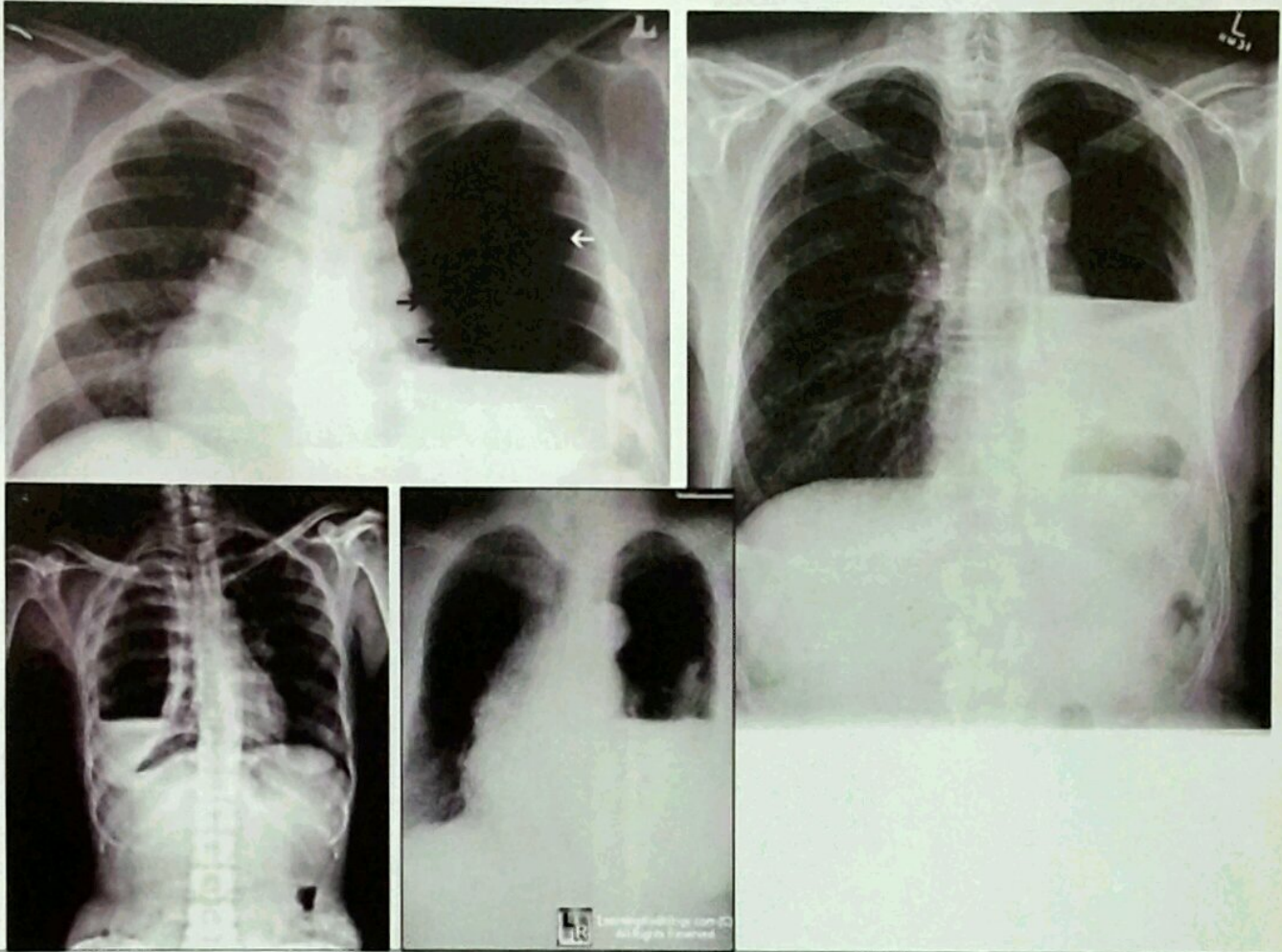
**NB :** encysted pleural effusion : upper level convex upward ( D-shaped)

• **Causes of bilateral pleural effusion :**

- Generalized anasarca, Systemic diseases (RA, SLE) & bilateral lung diseases.



## 2- Hydropneumothorax



❖ There is **line of pleura** forming the lung edge:

- **Outside this line :**

- **Above :** homogenous jet black hypertranslucency devoid of lung markings
- **Below :** homogenous opacity obliterating costophrenic angle on the ... side & has horizontal Fluid level;(flat upwards) (air fluid level)

- **Inside this line :** the collapsed lung lies close to the mediastinum.

❖ ± **Mediastinal shift to opposite side & the cupula of diaphragm may be flattened or depressed**

**Diagnosis :** Hydropneumothorax , (NB : encysted hydropneumothorax)

### B- Triangular opacity with it's base ... :

- **Peripheral :**



**Diagnosis :** Pulmonary infarction

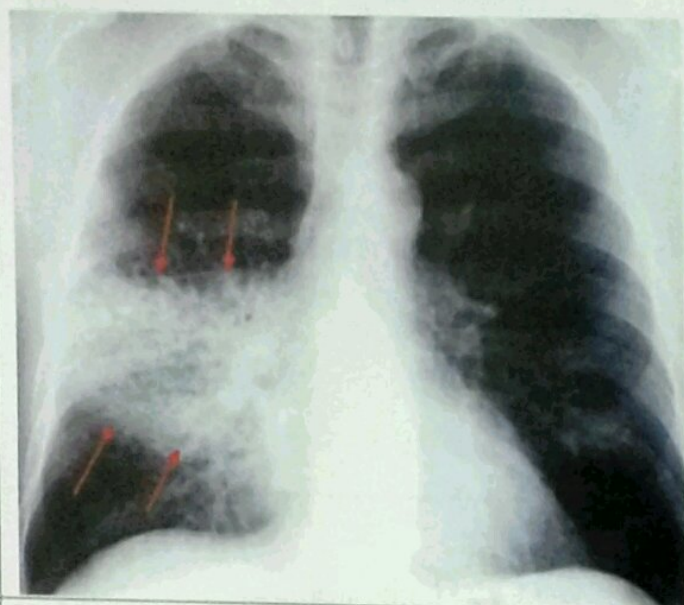
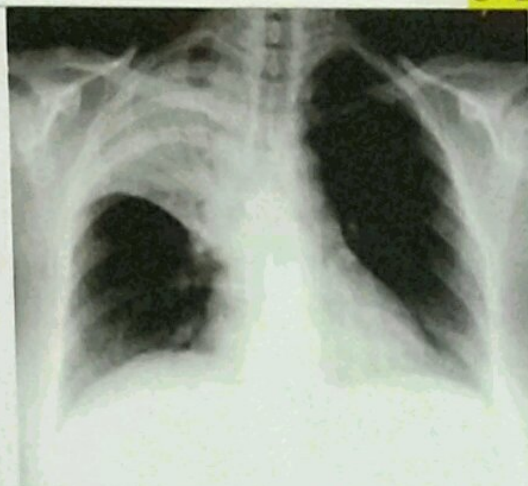
- **Inwards :**



**Diagnosis :** Pneumonic patch



### C- Lobar opacity



Homogenous opacity of the (e.g. right upper) lobe with ...

**Central** mediastinum

**Shifted** mediastinum to the same side of the lesion which is ... side

Normal sized lobe

Triangular concave sharp lower border of shrunken lobe

Normal spaced ribs & diaphragm

Crowded ribs & elevated (tenting) diaphragm if the lesion in lower lung zones

**Diagnosis :** lobar consolidation (pneumonia) ± lung abscess.

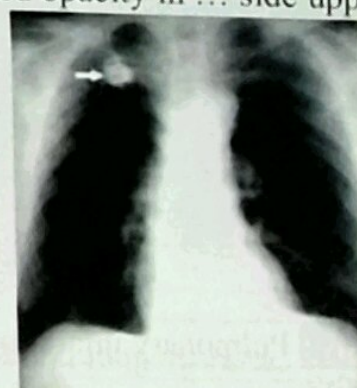
**Diagnosis :** lobar collapse

### D- Rounded opacity :

- **Apical shadow :** Homogenous, circular, well circumscribed opacity in ... side upper lung zone.

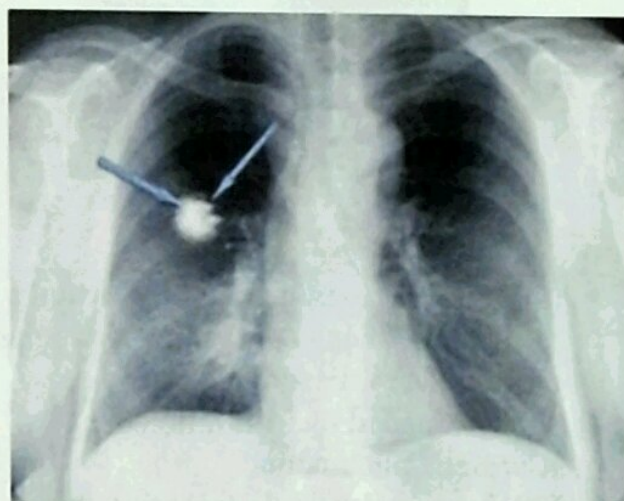
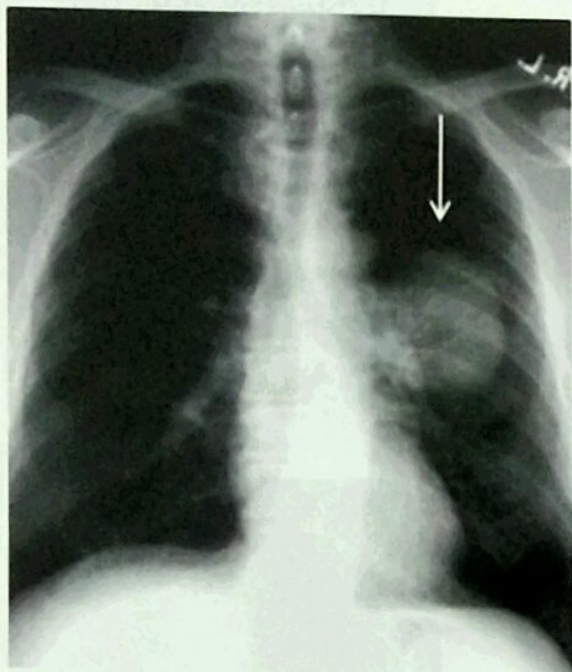
▪ **Diagnosis :**

- ❖ Apical shadow for DD:
  - Apical TB fibrosis
  - Pancoast tumor
  - Klebsiella pneumonia
  - Pleural thickening





• **Coin shadow = pulmonary nodule:**

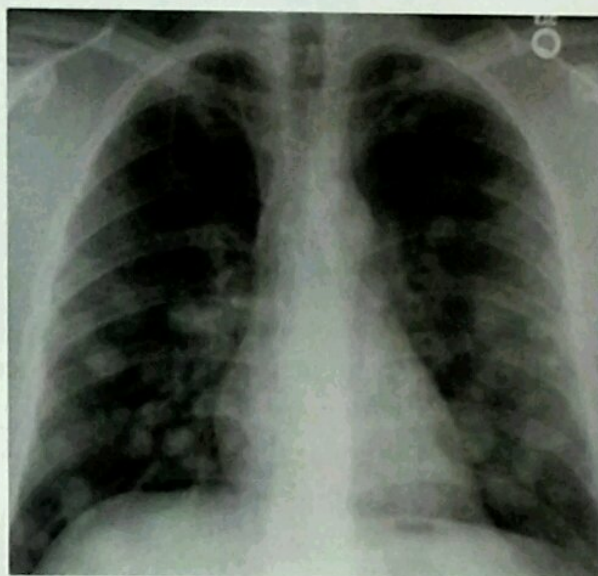
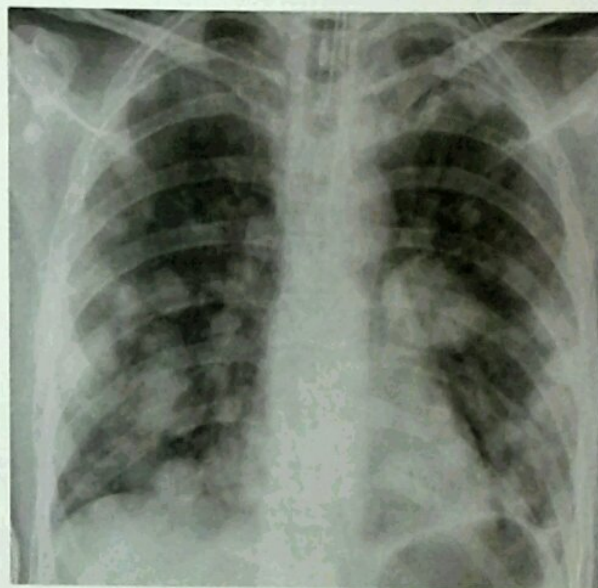


**Single unilateral**

Homogenous, circular, well circumscribed (or ill-defined) opacity in ... side ... lung zone .

**NB:** If outer Peripheral opacity : rise the suspicious of chest wall lesion or methothelioma

• **Cannon balls:**



**Multiple bilateral**

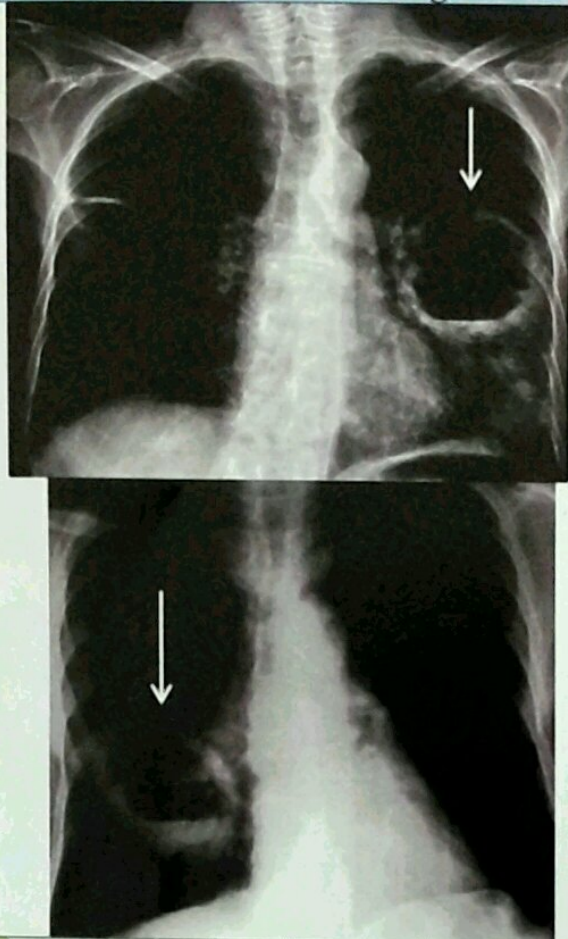
➤ **Diagnosis :** (Coin shadow or Cannon balls) for DD :

- TB ( tuberculoma)
- Tumor :
  - Benign : bronchial adenoma
  - Primary malignant : bronchogenic carcinoma
  - Secondary : single metastasis e.g. hypernephroma
- Lung cyst (hydatid)
- Pneumonic patch

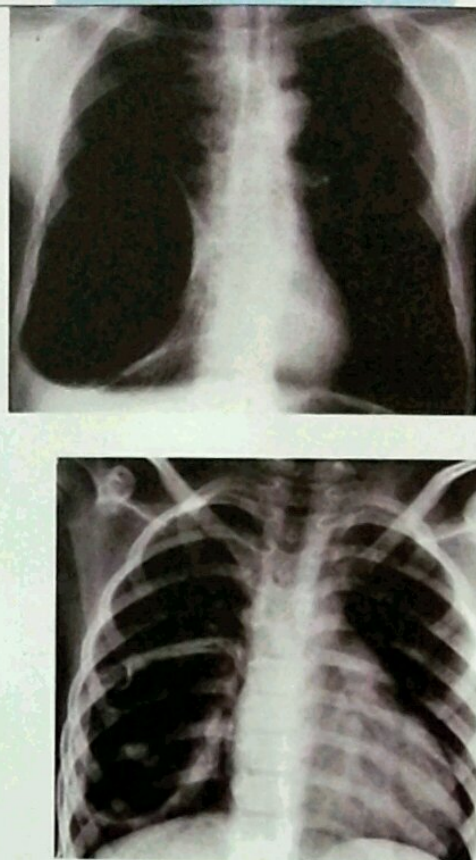


• **Cavity = ring opacity :**

▪ **With air fluid level = Lung abscess**



▪ **Without air fluid level**



**Acute**

Irregular thin wall surrounded with consolidation

**Chronic**

Regular thick wall , no consolidation , usually with pulmonary fibrosis

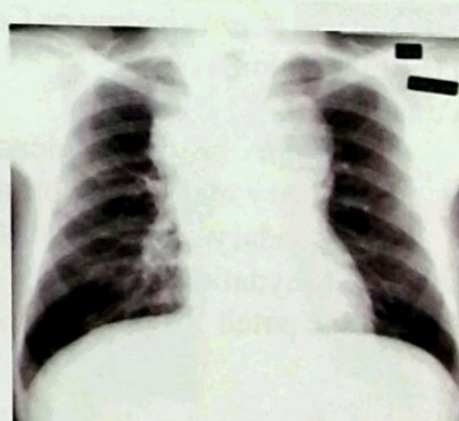
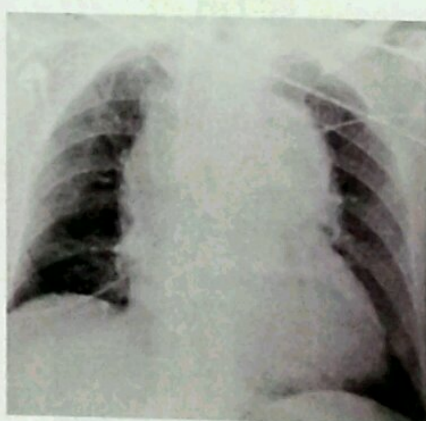
➤ **Diagnosis :** The ... side ... lung zone show homogeneous ring opacity ,... x ... cm with ... wall and the cavity showing air fluid level suggesting of ... lung abscess

➤ **Diagnosis :** Homogenous ring opacity in ... side ... lung zone with ... (regular or irregular) wall for DD :

- TB surrounded by infiltration
- Klebsiella pneumonia
- Emphysematous bulla (associated with emphysema)
- Cyst : congenital , hydatid , retention cyst

**E- Wide mediastinum : Broad superior mediastinum for DD:**

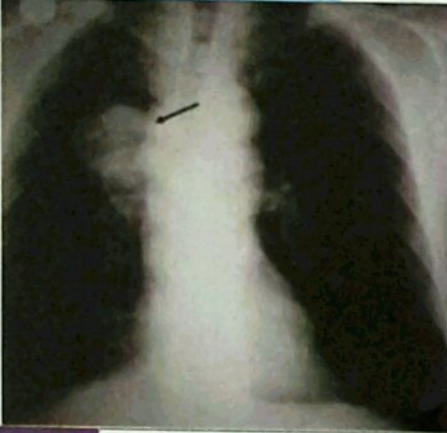
- Aortic aneurysm , Bilateral Lymphadenopathy , Dermoid cyst , Thymoma or Retrosternal goiter .





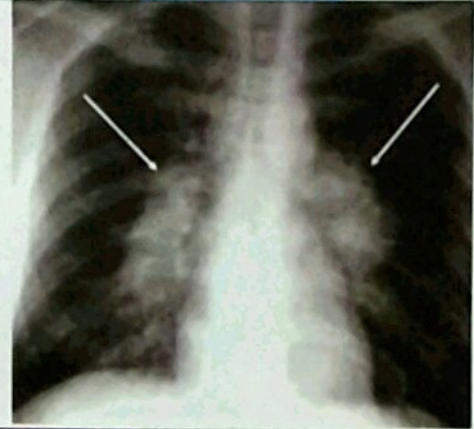
## F- Hilar opacity (mediastinal) :

### • Unilateral :



- **Diagnosis :** Unilateral Hilar opacity for DD:
- Bronchogenic carcinoma
  - Ghon's focus
  - LN (if lobulated "festooned" rise the suspicious to malignant LN)

### • Bilateral :



- **Diagnosis :** Bilateral Hilar opacity for DD:
- **Infections :**
    - TB
    - Viral : infectious mononucleosis
    - Fungal : histoplasmosis
  - **Neoplastic :**
    - Bronchogenic carcinoma
    - Lymphomas , lymphatic leukemia
  - **Sarcoidosis**
  - **Inhalational :** silicosis

## G- Homogenous opacification of (... side) hemithorax (whole lung):

### • Central mediastinum

- **Either** Pleural effusion with underlying collapse (or fibrosis) ولكن بتعادل
- **Or** Total lung pneumonia



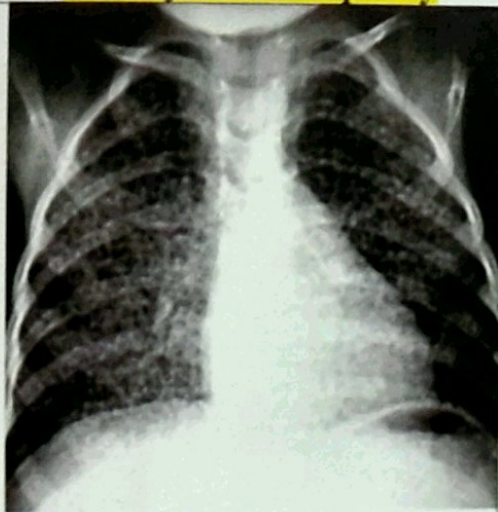
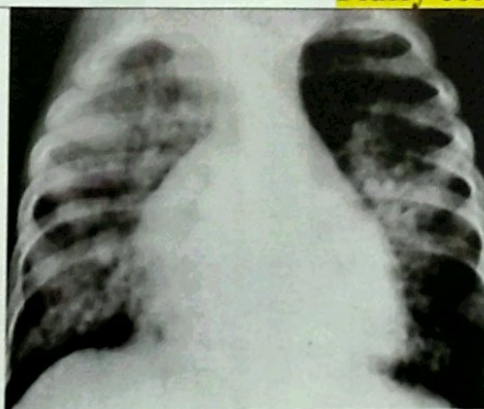
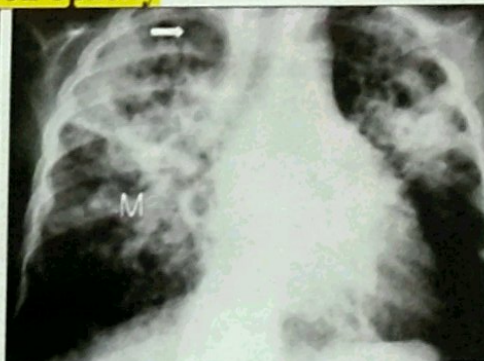
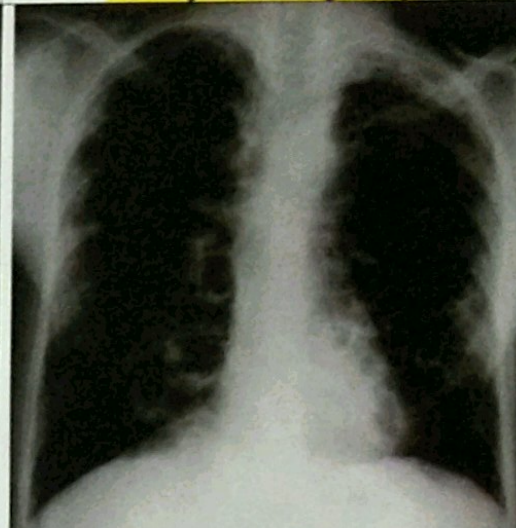
### • Shift of mediastinum

- **Same side :** either
  - Pleural effusion with underlying collapse (or fibrosis) التليف الأقوى **or**
  - Total lung collapse (or fibrosis) , crowded ribs , scoliotic vertebral column , there is compensatory emphysema on the other side



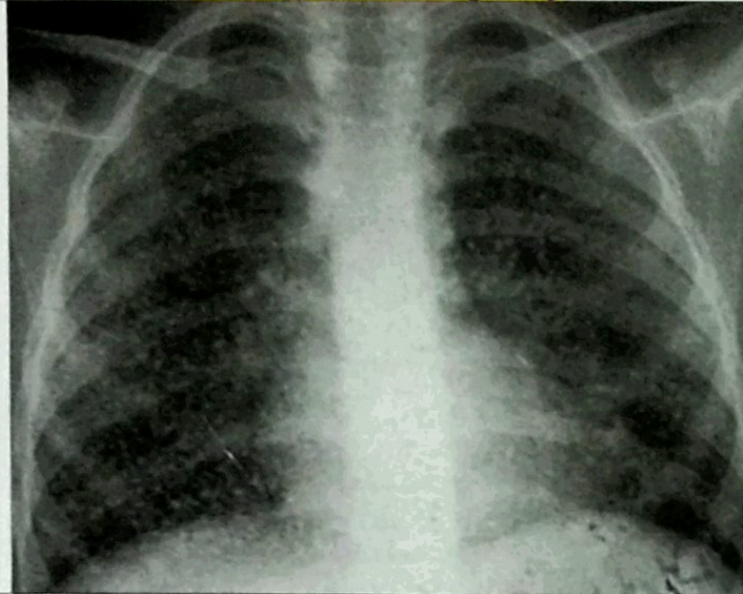
- **Opposite side:** massive pleural effusion. (see before)



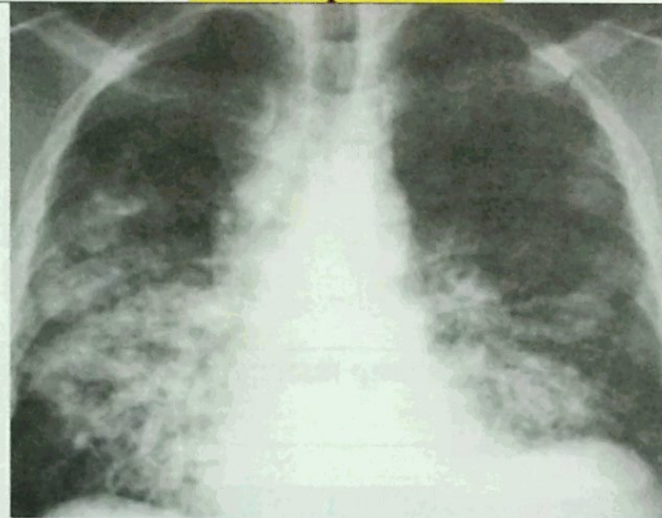
| II- Heterogenous :                                                                                                                                                                                                |                                                                                    |                                                                                     |                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Miliary shadow opacity                                                                                                                                                                                            | Fluffy cotton opacity                                                              |                                                                                     | Honey comb opacity                                                                                                                                                                                                                           |
|                                                                                                                                   |  |  |                                                                                                                                                           |
| Heterogeneous opacities , multiple, bilateral ,                                                                                                                                                                   |                                                                                    |                                                                                     |                                                                                                                                                                                                                                              |
| Diffuse (all over both lungs)                                                                                                                                                                                     | Diffuse mainly basal                                                               | Apical ( $\pm$ cavitation $\pm$ fibrosis)                                           | basal                                                                                                                                                                                                                                        |
| Pinpoint (rounded) opacities                                                                                                                                                                                      | irregular ill-defined opacities give fluffy cotton appearance                      |                                                                                     | <ul style="list-style-type: none"> <li>• Small ring opacities give honey comb appearance</li> <li>• There are hypertransluceny in the upper part of lungs due to emphysema.</li> </ul>                                                       |
| <p>➤ <b>Diagnosis :</b> Miliary shadow</p> <p>For DD :</p> <ul style="list-style-type: none"> <li>- Miliary TB</li> <li>- Lymphangitis carcinomatosis</li> <li>- Pneumoconiosis</li> <li>- Sarcoidosis</li> </ul> | <p>➤ <b>Diagnosis :</b> Most probably Bronchopneumonia</p>                         | <p>➤ <b>Diagnosis :</b> Most Probably TB</p> <p>Bronchopneumonia</p>                | <p><b>Diagnosis :</b> Most probably Bronchiectasis</p> <p>NB :</p> <ul style="list-style-type: none"> <li>- Lesion maybe unilateral.</li> <li>- Bronchogram : it shows the dilated bronchi as cylindrical, saccular, or fusiform.</li> </ul> |



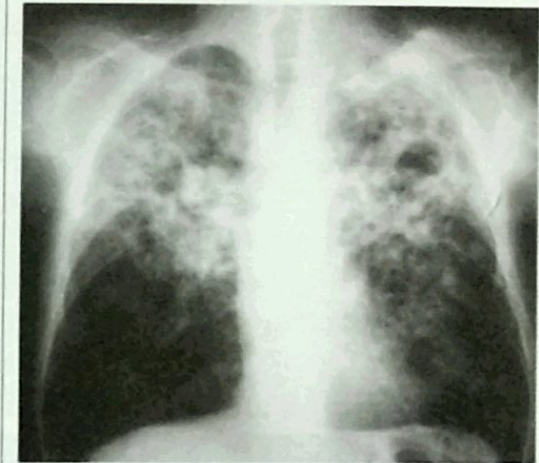
**Miliary shadow opacity**



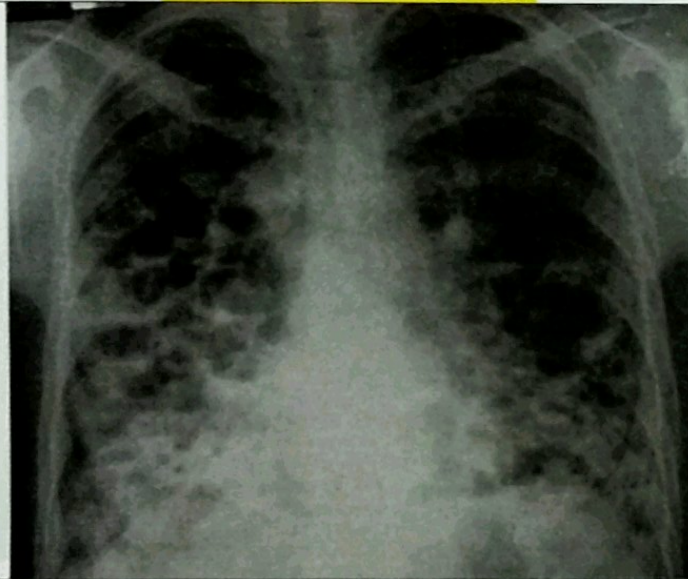
**Bronchopneumonia**



**TB bronchopneumonia**



**Bilateral Bronchiectasis**



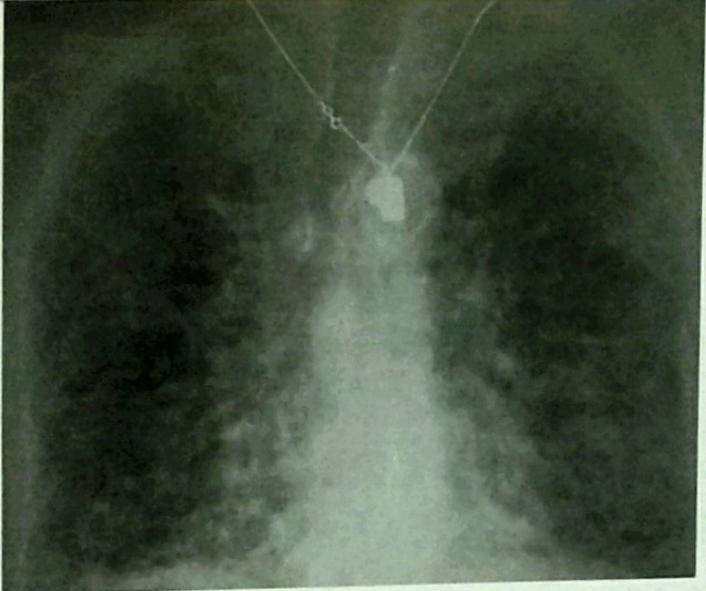
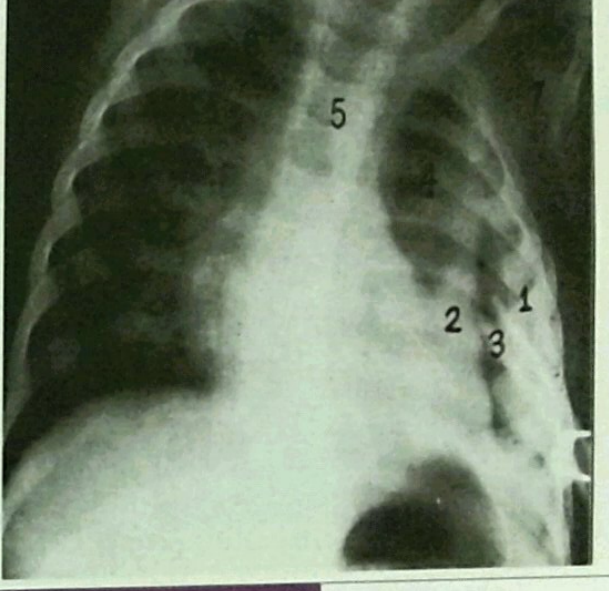
**Unilateral Bronchiectasis**



**Bronchography of Bronchiectasis**

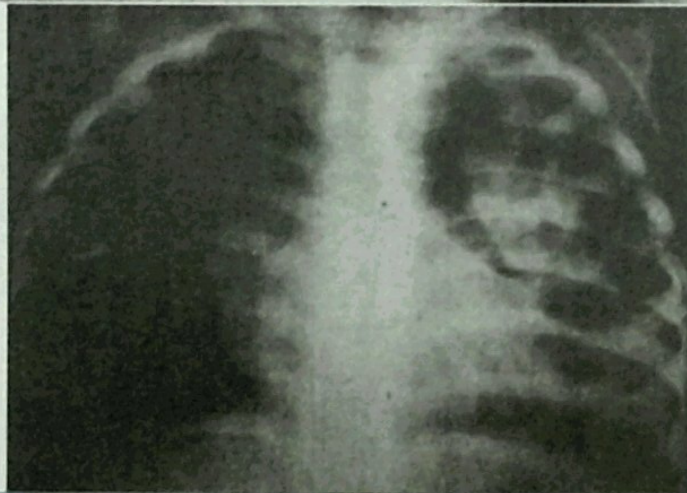
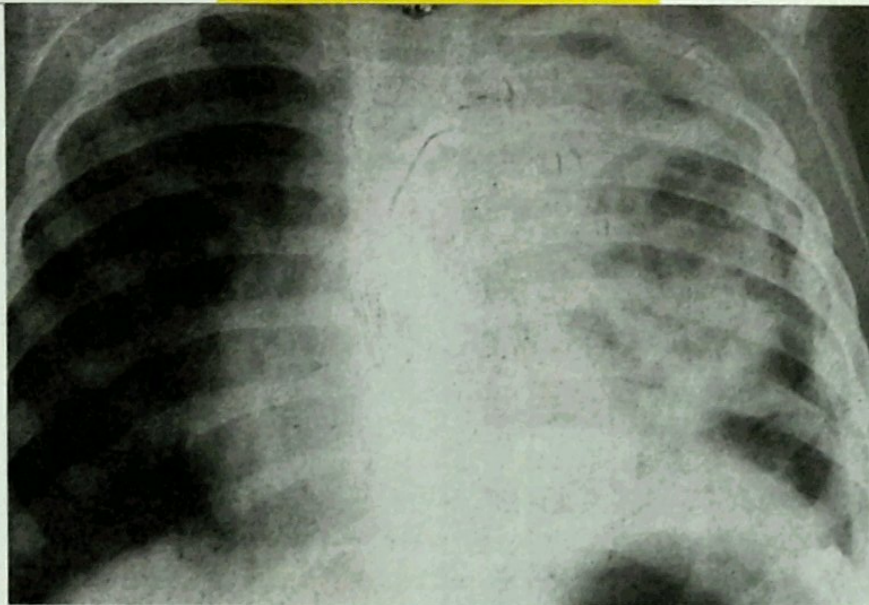




| <b>Idiopathic pulmonary Fibrosis (IPF)</b><br><b>(Interstitial lung disease) (ILD)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Lung fibrosis</b><br><b>(Parenchymatous fibrosis)</b>                                                                                    | <b>Fibrothorax</b><br><b>(pleuropulmonary fibrosis)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <ul style="list-style-type: none"> <li>• <b>Bilateral diffuse reticulations &amp; micronodular infiltrations (ground glass appearance) in the interstitial tissue of lungs</b></li> <li>• Crowded ribs, tenting (elevated) of diaphragm ,</li> <li>• Mediastinal shift to the same side of the lesion (± in IPF as it's bilateral disease)</li> <li>• <b>NBs : Types Of Fibrosis :</b> <ol style="list-style-type: none"> <li><b>1. Pulmonary fibrosis :</b> <ol style="list-style-type: none"> <li><b>A. Idiopathic pulmonary fibrosis; IPF</b> <ul style="list-style-type: none"> <li>- Occurs in between alveoli , in the interstitial tissue.</li> </ul> </li> <li><b>B. Parenchymatous fibrosis :</b> <ul style="list-style-type: none"> <li>- Occurs in lung parenchyma as a complication of various lung diseases e.g. TB &amp; lung abscess</li> </ul> </li> </ol> </li> <li><b>2. Pleuro-Pulmonary Fibrosis = Fibrothorax</b> <ul style="list-style-type: none"> <li>Pleural disease may heal by extensive fibrosis that extend to the lung parenchyma as a complication of hemothorax &amp; empyema</li> </ul> </li> </ol> </li> <li>➤ <b>Q: What are the differential diagnosis of ground glass appearance ? A: See later.</b></li> </ul> | <ul style="list-style-type: none"> <li>• <b>Unilateral fibrosis appears as heterogeneous opacity in the left lung parenchyma</b></li> </ul> | <ol style="list-style-type: none"> <li><b>1. Unilateral fibrosis</b> appears as heterogeneous opacity in left hemithorax; left pleura and lung pleura more dense (more affected), crowded ribs , mediastinal shift to the same side of the lesion which is left, tenting (elevated) of diaphragm</li> <li><b>2. Collapsed lung</b></li> <li><b>3. Chest tube</b></li> <li><b>4. Pneumatocele</b></li> <li><b>5. Scoliotic changes of the spine.</b></li> <li><b>6. Other side ( RT ) ,</b> there is compensatory emphysema.</li> <li><b>7. Patient body is tilted to the left side</b></li> </ol> |

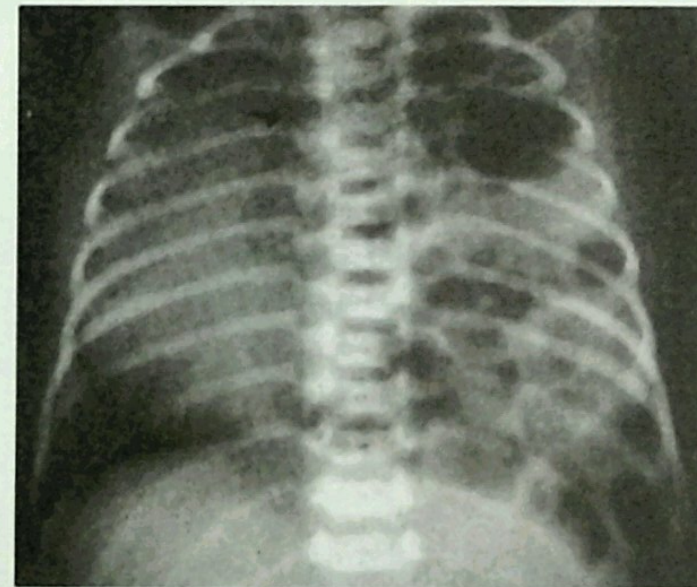
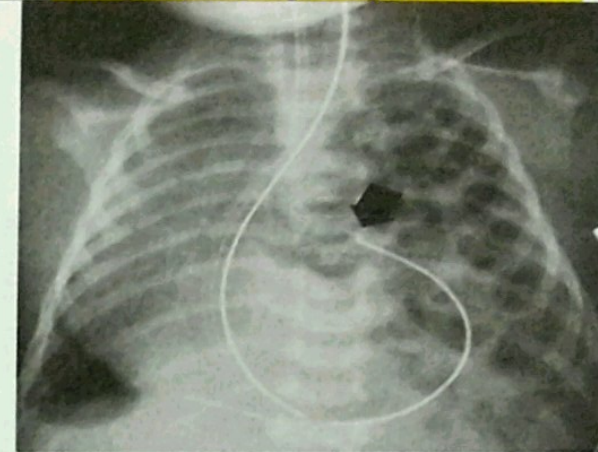


### Pneumonia + Pneumatocele



- **Central** mediastinum
- Heterogeneous radiopaque shadows scattered in the upper, middle & lower part of left lung (**Pneumonia**) intermingled with hyperlucent cystic shadows (**Pneumatocele**)

### Congenital diaphragmatic hernia



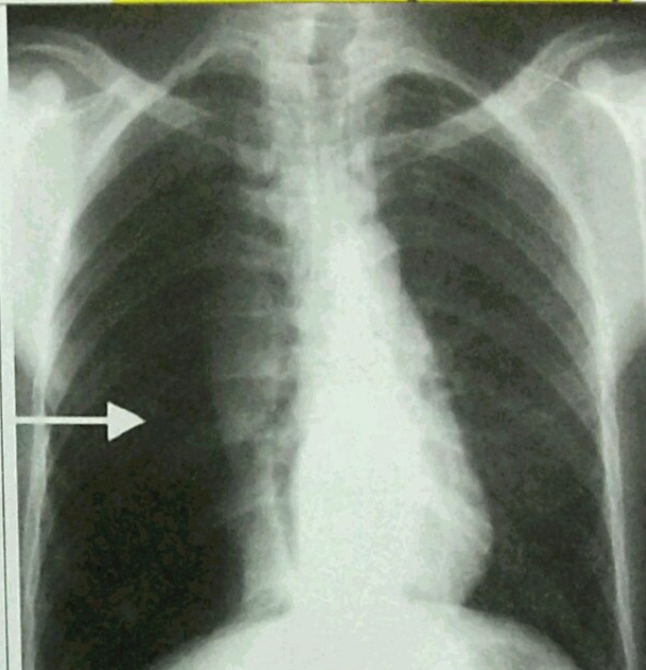
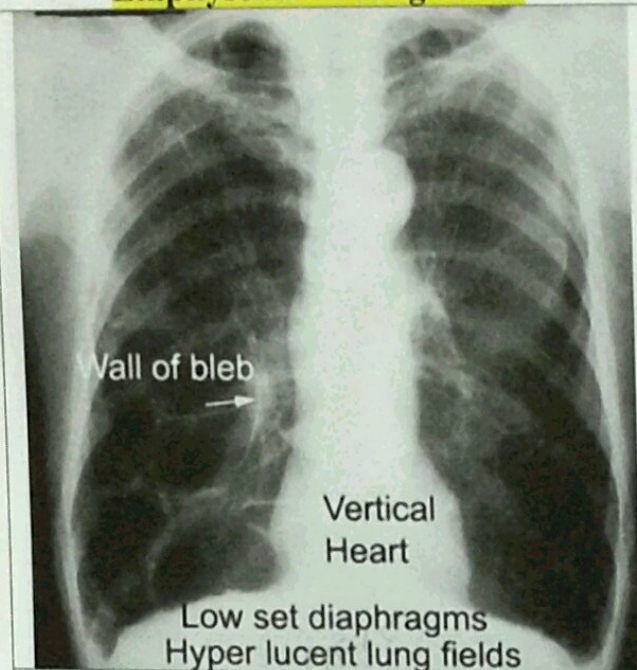
- **Shifted** mediastinum to other side of the lesion.
- Heterogeneous radiopaque shadows simulating pneumonia intermingled with hyperlucent cystic shadows simulating Pneumatocele but there are actually **the herniated intestinal loops ; left side congenital diaphragmatic hernia**



## ❖ Lung Hypertranslucency:

### Emphysema → lung tissue

### Pneumothorax → pleural cavity



Bilateral **hypertranslucency** with increased **bronchovascular markings** of voluminous lungs

Unilateral ( ... side) homogenous jet black **hypertranslucency** with absent **bronchovascular markings** without lung tissue occupying ( RT OR LT ) hemithorax

Bilateral wide transverse **ribs & intercostal spaces**

Unilateral ( ... side ) wide transverse **ribs & intercostal spaces**

Bilateral low flat **diaphragm** ( lower than 10<sup>th</sup> rib posteriorly)

Look for rib fracture in traumatic pneumothorax

Unilateral low flat **diaphragm** ( lower than 10<sup>th</sup> rib posteriorly )

Central **mediastinum**

**Mediastinal** shift to opposite side “ tension pneumothorax ”

**Heart** shadow is elongated “Ribbon shaped heart ( decreased cardiothoracic ratio)

Near by underlying **lung** collapse lies close to the mediastinum

#### **NB:**

- **Emphysematous bulla** maybe present
- **In case of cor- pulmonale** : the right ventricle enlarges with acute angle
- **Unilateral emphysema** may occur in compensatory cases e.g. collapse , fibrosis or resection.

#### **NB:**

- **Intercostal tube** maybe present
- **Encysted pneumothorax**
- **Bilateral pneumothorax**

### ❖ Q : What are the differential diagnosis of Ground Glass Appearance (GGA) ?

1. Opportunistic infections e.g. atypical pneumonia, pneumocystis carinii pneumonia, cytomegalovirus ,
2. Alveolar disease e.g. alveolar edema e.g. cardiogenic pulmonary edema & acute respiratory distress syndrome
3. Interstitial lung disease (ILD) e.g. hypersensitivity pneumonitis, Hamman-Rich syndrome , Idiopathic pulmonary fibrosis.
4. Neoplastic causes e.g. atypical adenomatous hyperplasia
5. Others e.g. aspergillosis , sarcoidosis, lymphangitic carcinomatosis





**Emphysema → lung tissue**

**Emphysema**

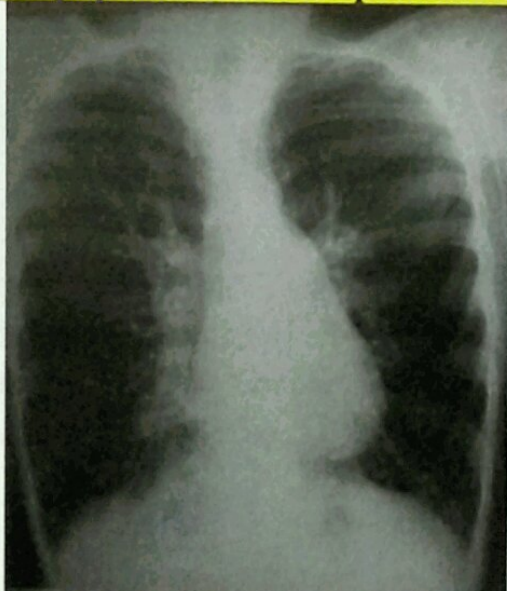


**Pneumothorax → pleural cavity**

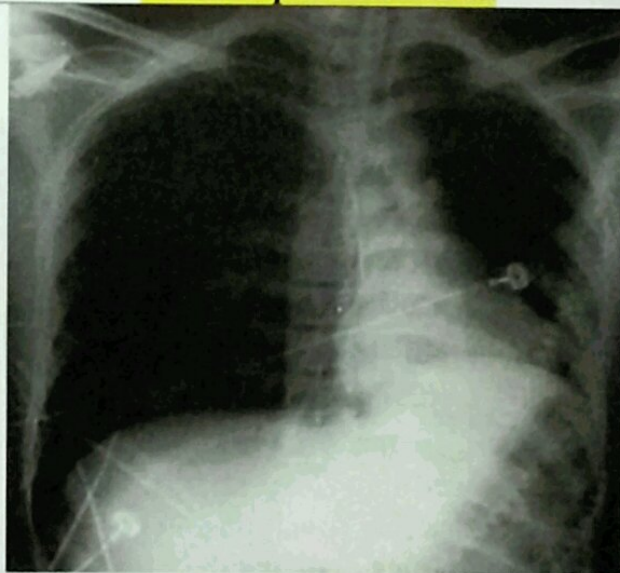
**Unilateral Pneumothorax**



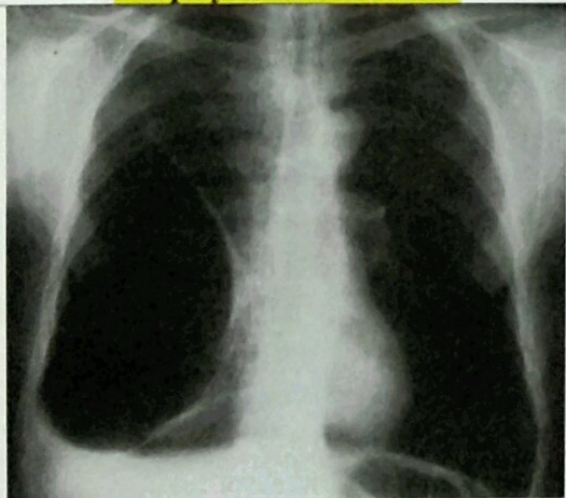
**Emphysema with cor- pulmonale**



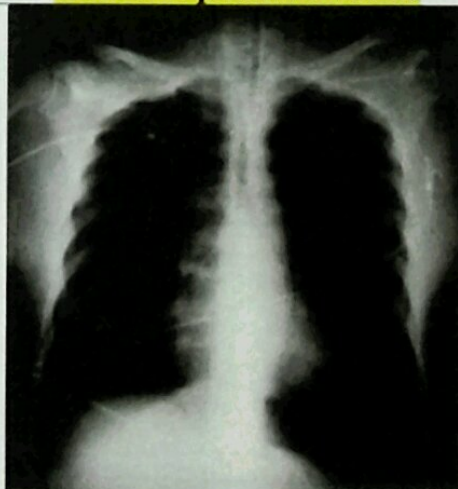
**Tension pneumothorax**



**Emphysematous bulla**

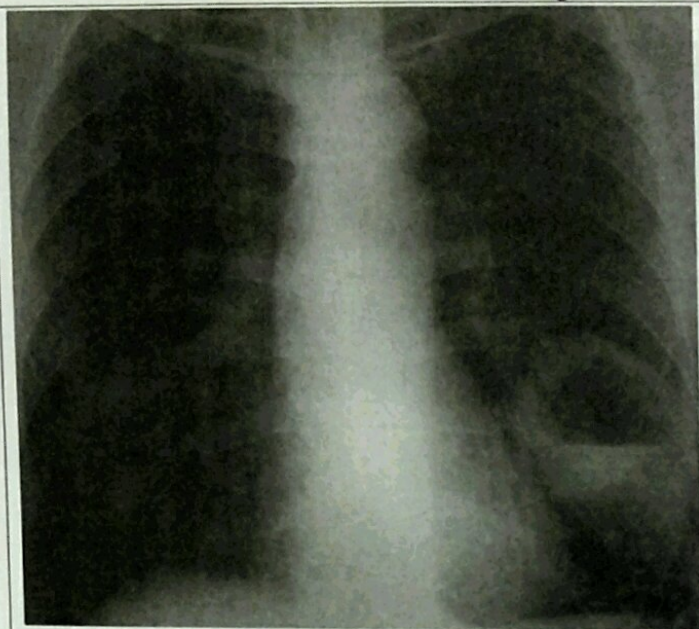


**Bilateral pneumothorax**





### Examples for full comment



- **P**lain X-ray chest & heart.
- **P**osteroanterior view
- **P**atient is not centralized
- **P**osition of mediastinum (trachea & heart) is central
- **P**atient gender is adult male
- **B**ony cage is intact
- **C**ostophrenic angles are free on both sides
- **C**ardio-thoracic ratio is normal ratio.
- **D**iaphragm :Cuts the 6<sup>th</sup> rib anteriorly
- **L**ung field : bilateral increase in Bronchovascular markings
- **S**ite, **S**ize, **S**hape, **S**hadow, **S**everity :
  - The left lower lung zone shows homogeneous ring (oval) opacity , 4 x 6 cm with regular thick wall and the cavity showing air fluid level suggesting of chronic lung abscess
- ❖ **Diagnosis : left lower lobe lung abscess**

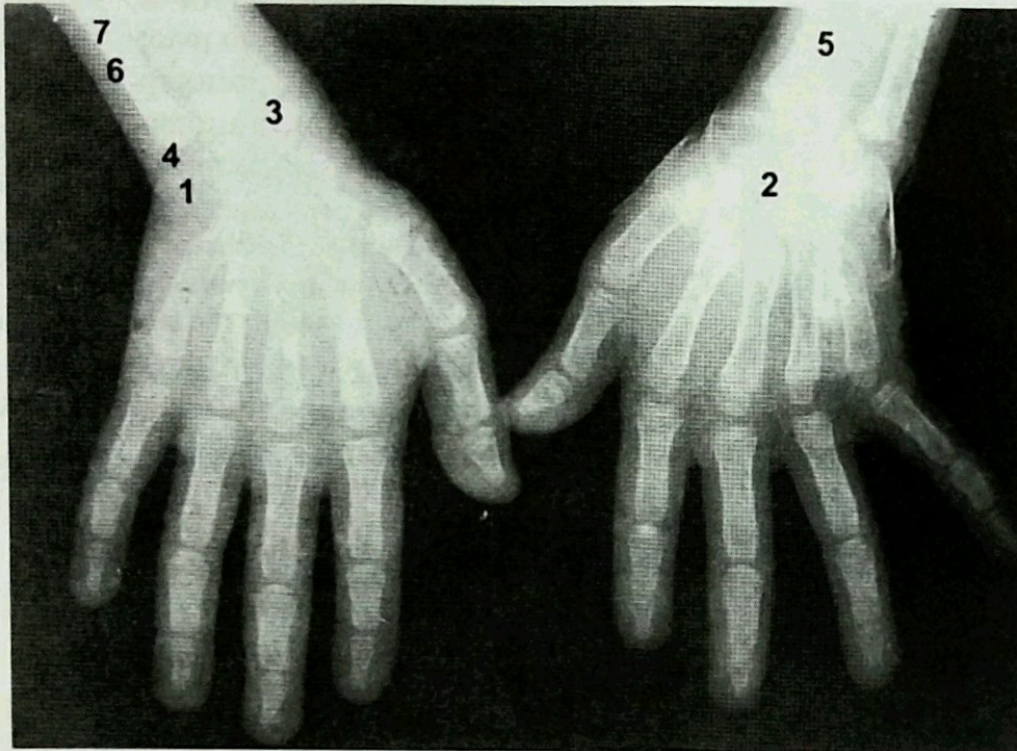


- **P**lain X-ray chest & heart.
- **P**osteroanterior view
- **P**atient is centralized
- **P**osition of mediastinum :
  - Trachea is central while the heart is shifted to opposite side of the lesion; shifted to the left.
- **P**atient gender is adult male
- **B**ony cage is intact
- **C**ostophrenic angles are free on the left side while on the right side they are obliterated .
- **C**ardio-thoracic ratio can't be assessed.
- **D**iaphragmatic cupola on the right side : is depressed
- **L**ung field : there is a line of pleura forming the lung edge:
- **Outside this line :**
  - **Above :** homogenous jet black hypertranslucency devoid of lung markings
  - **Below :** homogenous opacity obliterating costophrenic angle on the right side & has horizontal Fluid level;(flat upwards) (air fluid level)
- **Inside this line :** the collapsed lung lies close to the mediastinum.
- **Diagnosis :right sided hydropneumothorax**



## Bone X-rays

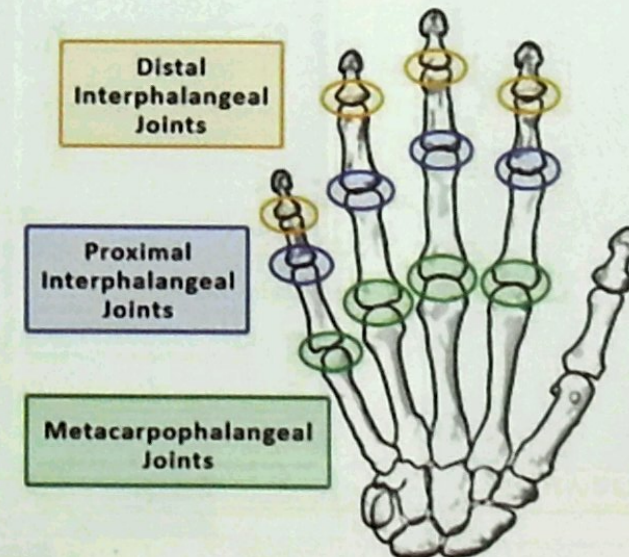
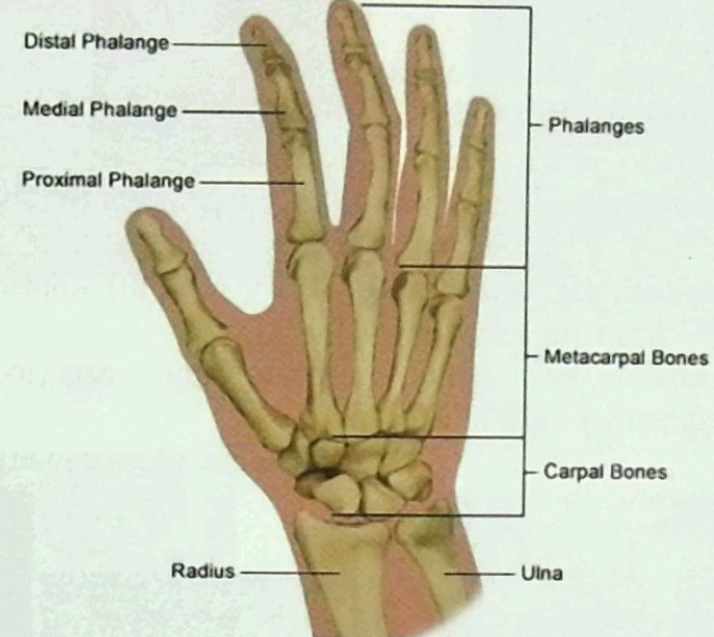
### Normal Hand X-Ray



❖ Plain X-ray wrist joints showing :

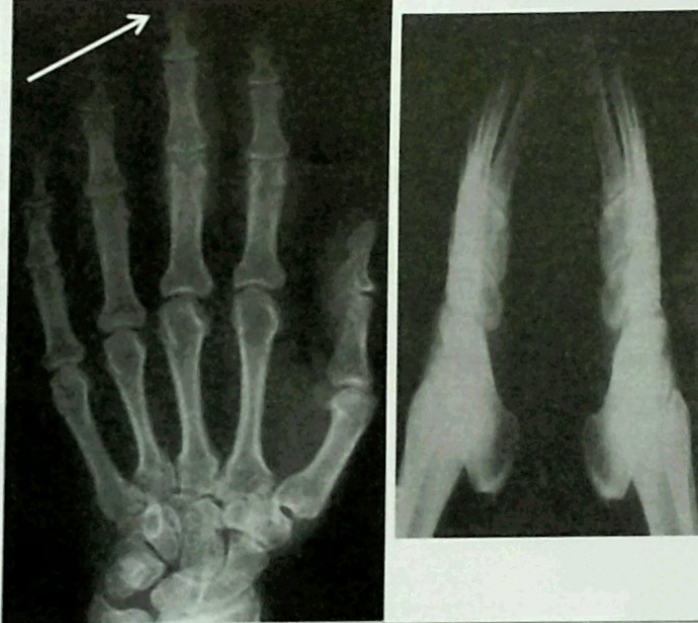
1. Joint space
2. Ossific centers of carpal bones  
Bone age is determined roughly by calculating the number of carpal ossific centers minus one
3. Epiphyseal ossific center (radius)
4. Epiphyseal line (line of provisional calcification)
5. Diaphysis
6. Cortex
7. Medulla

### Anatomy of the Hand





## Hands & Feet – X-rays

| Diagnosis   | Rheumatoid arthritis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Acromegaly                                                                         |                                                                                     | Gouty arthritis |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------|
|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |  |                 |
| View        | Plain X-Ray, Hand or foot, Posteroanterior (dorsopalmar)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                    |                                                                                     |                 |
| Description | <div><div><p>• <b>NB:</b> Meta carpo phalangeal (MP) joints, proximal inter phalangeal (PIP) joints</p><ul style="list-style-type: none"><li>• <b>Bilateral symmetrical arthritis</b> affecting : MP &amp; PIP joints</li><li>• <b>Intercarpal arthritis</b> (amalgamated carpal bones) :<ul style="list-style-type: none"><li>- Narrowing of joint spaces</li><li>- Periarticular osteopenia</li><li>- Erosion of joints , Subchondral Sclerosis</li></ul></li><li>• <b>Deformities</b> e.g. Z shaped thumb deformity, swan neck , Boutonniere deformity, ulnar deviation of at the level of MP joint.</li><li>• <b>Subluxation</b> e.g. MP joints</li><li>• <b>Rarefaction (Osteoporosis)</b></li></ul></div><div><p>❖ <b>PA view :</b></p><ul style="list-style-type: none"><li>• Increased (hand or foot) size = bulky sized bones</li><li>• Increase soft tissue shadow (in hand X-ray called = spade hand)</li><li>• <b>Mushrooming</b> (tufting) of terminal phalanges</li><li>• ± Big sesamoid bones</li><li>• ± Bone rarefaction</li></ul></div><div><ul style="list-style-type: none"><li>• <b>In Hand :</b> Unilateral (or bilateral asymmetrical) arthritis affecting ...</li><li>• Irregular articular lines of bones</li><li>• Extra-articular punched out bone erosion (urate deposits)</li><li>• <b>Soft tissue shadow of tophi</b> (urate deposits around joints)</li></ul></div></div> |                                                                                    |                                                                                     |                 |

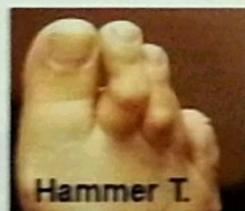
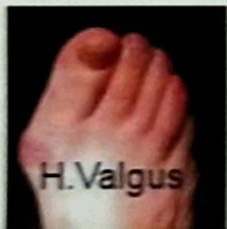


### Rheumatoid arthritis



#### ❖ In foot :

- Bilateral symmetrical arthritis affecting : metatarsophalangeal joints & interphalangeal joints :
  - Narrowing of joint spaces
  - Periarticular osteopenia
  - Erosion of joints
  - Subchondral Sclerosis
- **Deformities :**
  - Hallux valgus (lateral deviation of big toe)
  - Hammer toes (flexion deformities)



### Acromegaly



#### ❖ Lateral View :

- Big sized feet
- Increased calcanean pad thickness ( $>2.5$  cm)



### Gouty arthritis



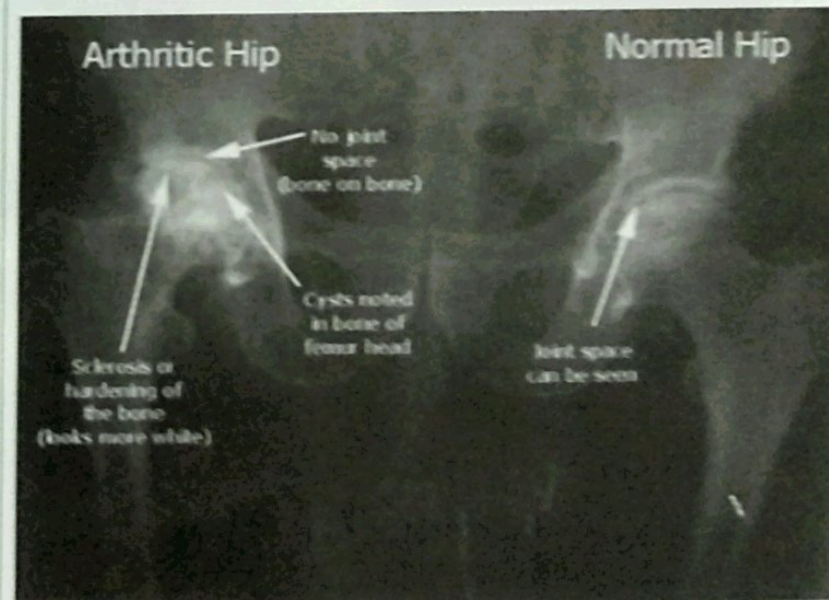
- In Foot : arthritis affecting first MP joint (Big toe) & same comment.



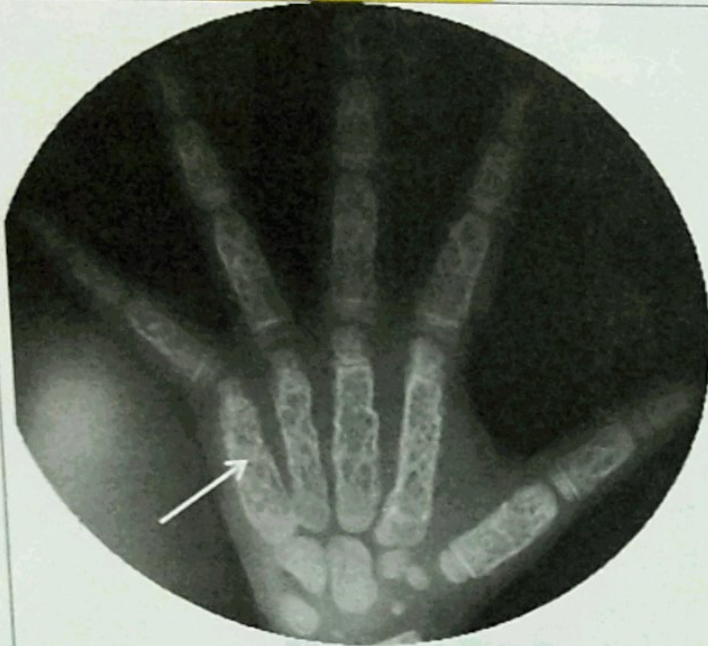
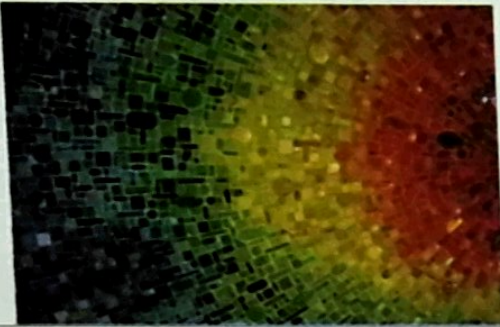
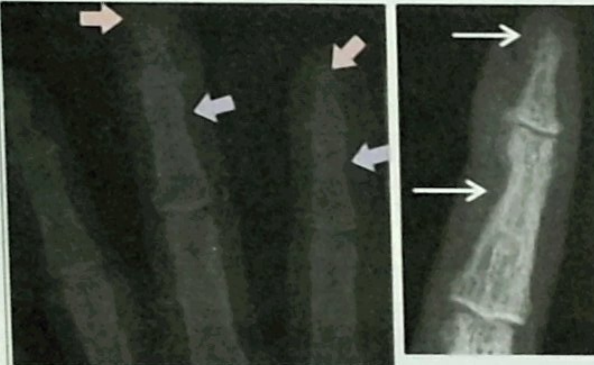


### Osteoarthritis (OA)

- View : Plain X-Ray, Hand or foot(hip, knee ,leg), Posteroanterior or lateral.
- Description :
  - **Bilateral symmetrical arthritis affecting DIP ( $\pm$ PIP) :**
    - Narrowing of joint spaces
    - Periarticular osteopenia
    - Erosion of joints e.g. DIP joints
    - Subchondral Sclerosis
    - Osteophytes giving Herberden (DIP) & Bouchard (PIP) nodules
    - No or minimal deformities





| Diagnosis   | Hemolytic anemia                                                                                                                                                                                                                                                           | Hyperparathyroidism                                                                                                                                                                                                                   | Scleroderma                                                                                                                                        |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                                                                                                         |                                                                  |                                                                |
| View        | Plain X-Ray, Hand, Posteroanterior (dorsopalmar)                                                                                                                                                                                                                           |                                                                                                                                                                                                                                       |                                                                                                                                                    |
| Description | <ul style="list-style-type: none"> <li>Boxing of bones &amp; loss of waist (rectangular shape)</li> <li>Thin cortex &amp; wide medulla cavity</li> <li>Lattice pattern due to trabeculation of bones (<b>mosaic appearance</b>)</li> <li>Decreased bone density</li> </ul> | <ul style="list-style-type: none"> <li><b>Resorption of terminal phalanges</b></li> <li><b>Subperiosteal phalangeal bone resorption</b> ( specially affecting middle phalanges)</li> <li>± Osteolytic lesion (Brown tumor)</li> </ul> | <ul style="list-style-type: none"> <li><b>Resorption of terminal phalanges</b></li> <li><b>Calcification in soft tissues of fingers</b></li> </ul> |

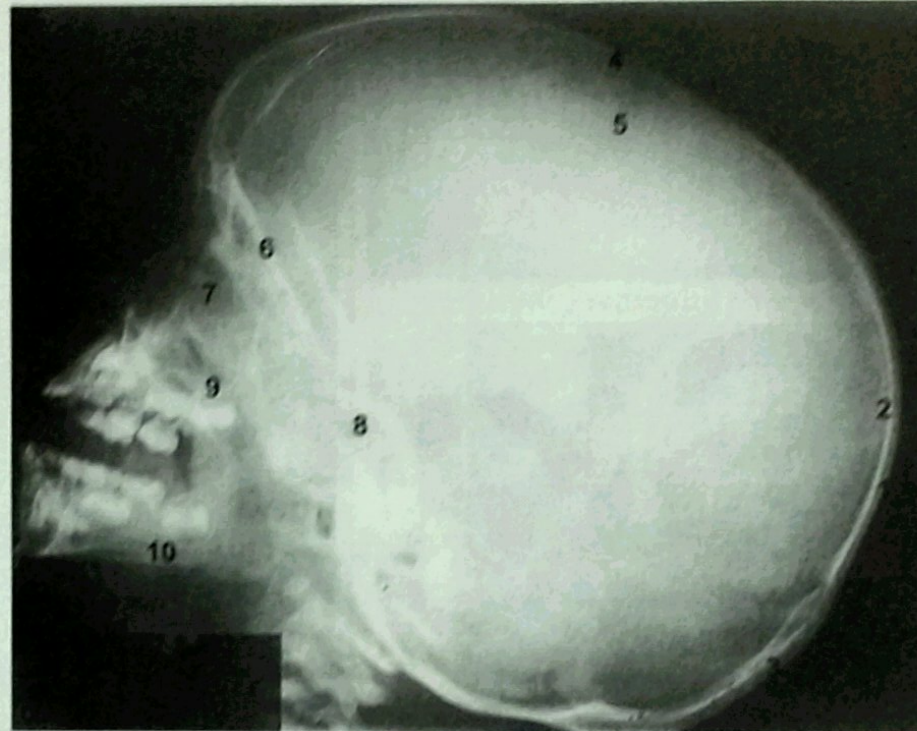


|             |                                                                                                    |                                                                                      |
|-------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Diagnosis   | Calcaneal spur                                                                                     |                                                                                      |
|             |                   |   |
| View        | <ul style="list-style-type: none"><li>• Plain X-Ray, foot, Lateral</li></ul>                       |                                                                                      |
| Description | <ul style="list-style-type: none"><li>• Spike or spur projecting from the calcaneal bone</li></ul> |                                                                                      |
|             | Hyperparathyroidism                                                                                |                                                                                      |
|             |                  |  |



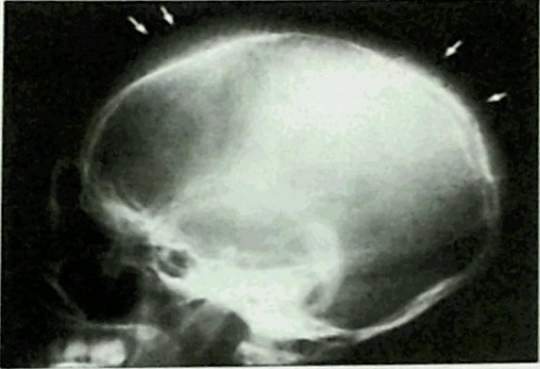
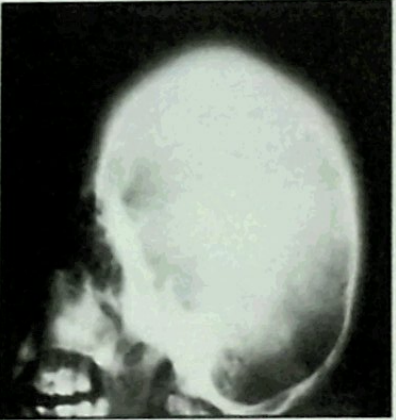
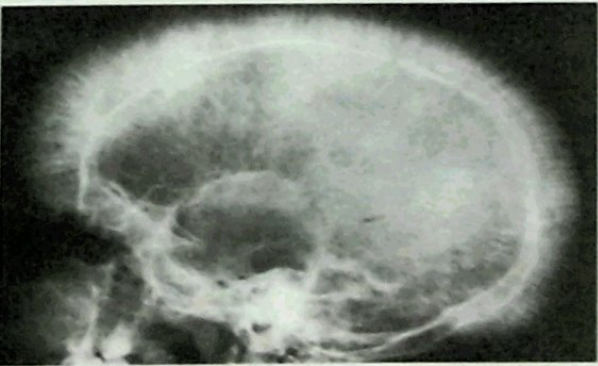
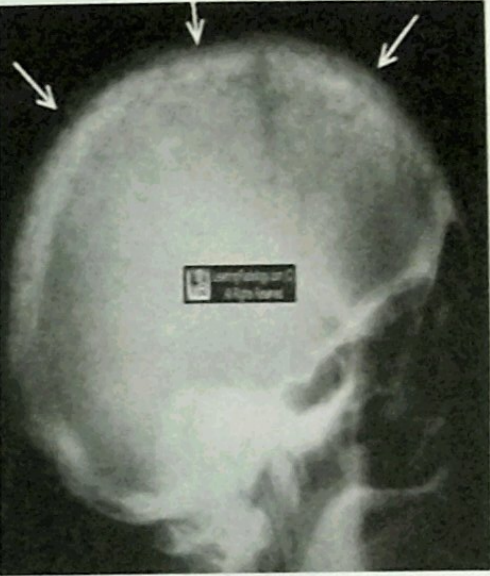
## Skull – X-rays

### Normal Skull X-ray



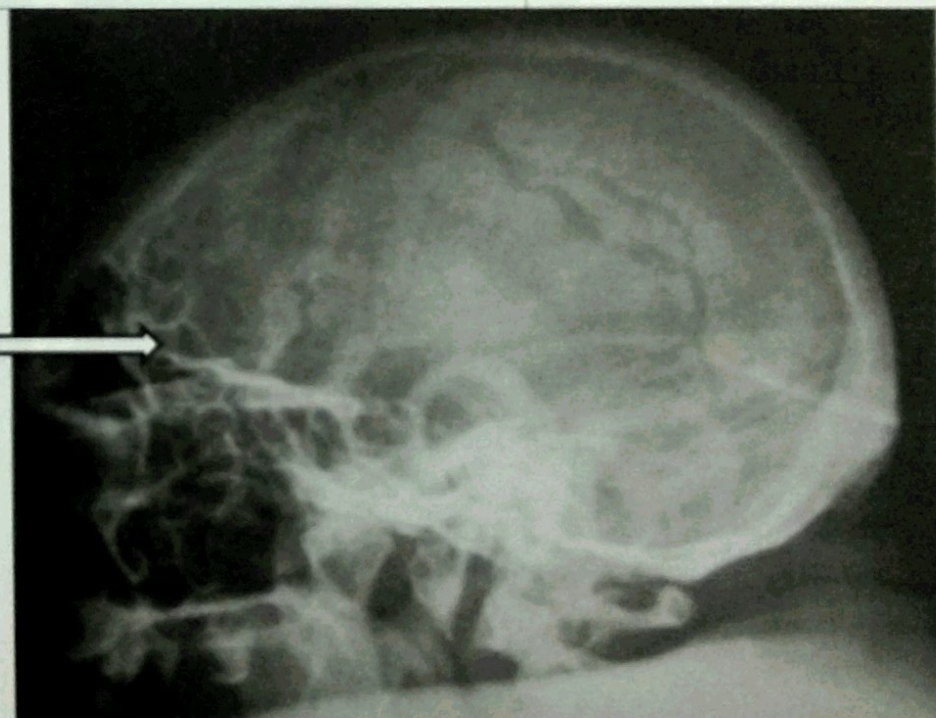
1. Outer table
2. Inner table
3. Diploic space
4. Anterior fontanelle
5. Coronal suture
6. Roof of the orbit
7. Orbit
8. Sella turcica; normally admit less than little finger.
9. Maxilla
10. Mandible



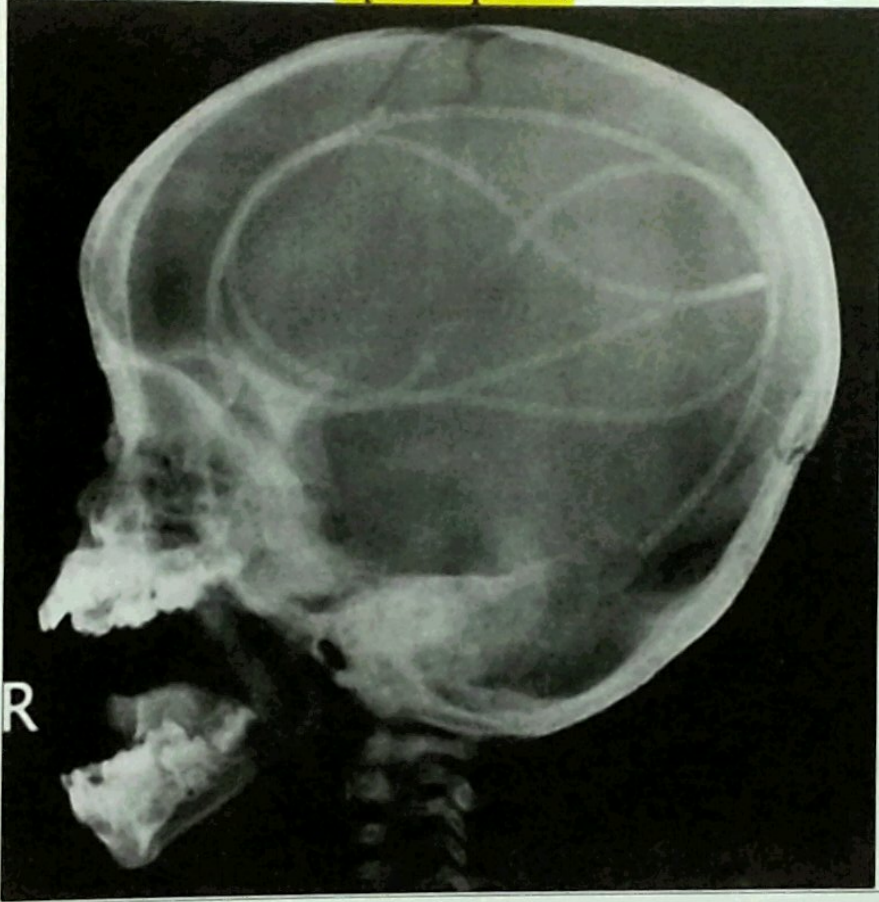
| Diagnosis | Acromegaly                                                                                                                                                              | Hemolytic anemia                                                                                                                                                                                                                                                    | Paget disease of the bone                                                                                                                                                   |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           | <br> | <br><br> | <br> |



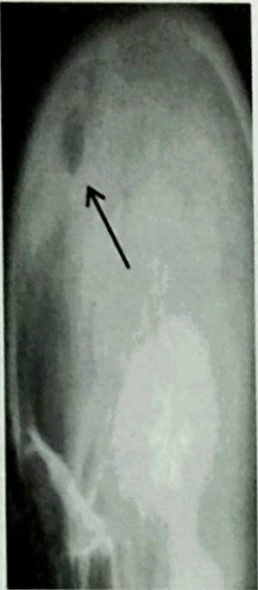
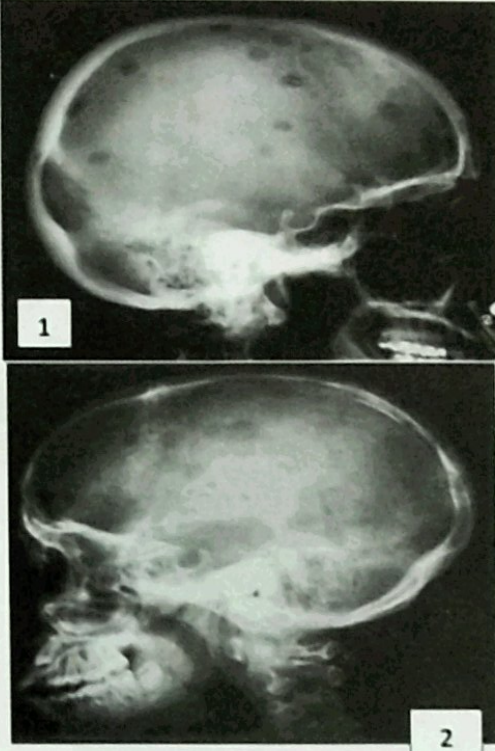
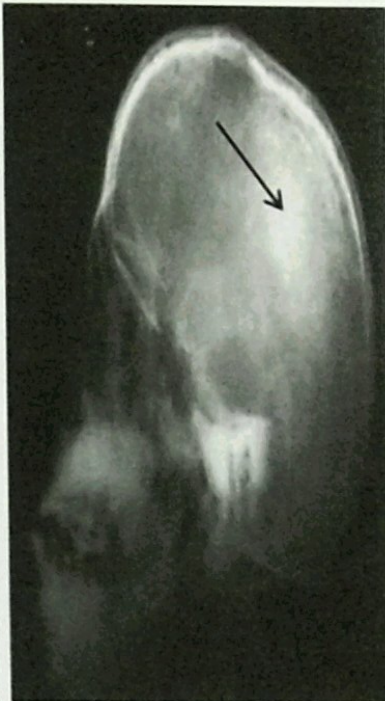
| View        | <b>Acromegaly</b><br>Plain X-Ray,<br>Skull,<br>Posteroanterior or lateral                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Hemolytic anemia</b><br>Plain X-Ray,<br>Skull,<br>lateral                                                                                                                                                                                                                                                                              | <b>Paget disease of the bone</b><br>Plain X-Ray,<br>Skull,<br>Lateral                                                                                                                                                                        |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description | <ul style="list-style-type: none"> <li>❖ <b>Posteroanterior view :</b></li> <li>• <b>B</b>ig skull</li> <li>• Increase <b>T</b>hickening &amp; widening of skull diploic space</li> <li>• <b>T</b>hick cortex.</li> <li>• <b>P</b>neumatization (Increase) frontal and maxillary air sinuses</li> <li>• <b>P</b>rominent orbital margins</li> <li>• <b>T</b>eeth either widely separated or falling</li> <li>❖ <b>Lateral View = PA +</b></li> <li>• <b>B</b>allooning or widening(&gt;little finger) of sella turcica</li> <li>• <b>B</b>ossing of forehead</li> <li>• <b>P</b>rognathism (protruded lower jaw)</li> <li>• <b>P</b>rominent external occipital protuberance</li> <li>• <b>B</b>ig soft tissue shadows: ears, tongue &amp; skin folds in nape.</li> <li>• ± Silver <b>B</b>eaten appearance = finger prints (↑ICT in adults)</li> </ul> | <ul style="list-style-type: none"> <li>• Big skull</li> <li>• Increase thickening &amp; widening of skull diploic space</li> <li>• Generalized rarefaction</li> <li>• Subperiosteal new bone formation in the form of radiating perpendicular widely separated prominent bony trabeculae giving <b>hair on end appearance</b>.</li> </ul> | <ul style="list-style-type: none"> <li>• Big skull</li> <li>• Increase thickening &amp; widening of skull diploic space</li> <li>• Generalized sclerosis(multiple irregular sclerotic patches) producing <b>cotton wool skull</b></li> </ul> |





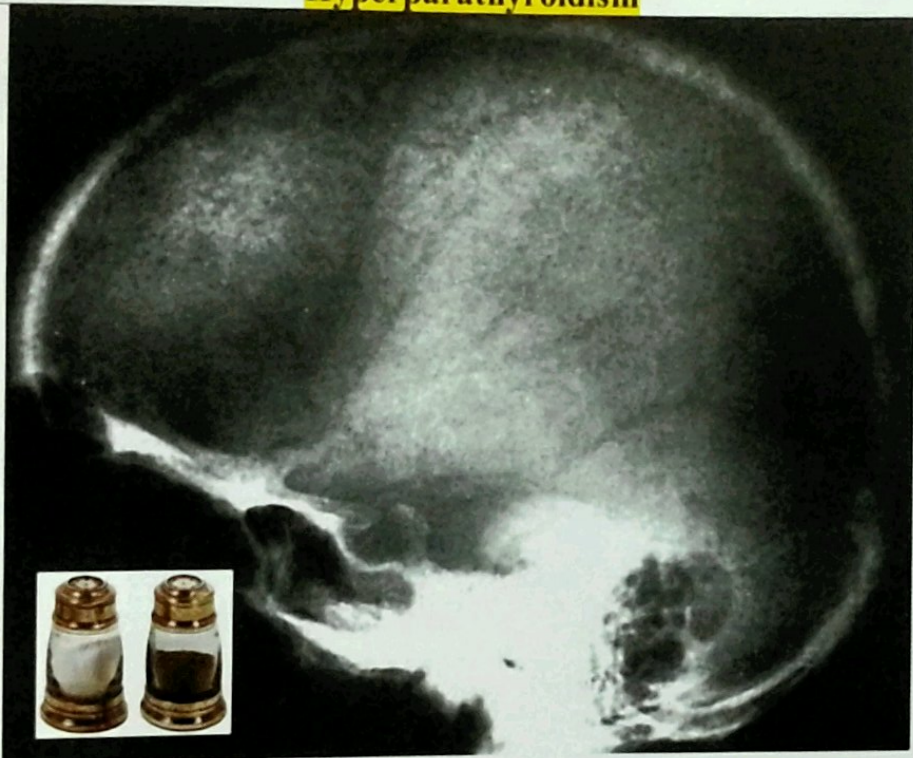
| Diagnosis   | Hydrocephalus                                                                                                                                                                                                                                                                                      | Craniosynostosis                                                                                                                                                                                                                                                                                                                           |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                        |
| View        | Plain X-Ray, Skull, lateral                                                                                                                                                                                                                                                                        | Plain X-Ray, Skull, lateral                                                                                                                                                                                                                                                                                                                |
| Description | <ul style="list-style-type: none"><li>• Big cranium &amp; small face (<b>disproportionate cranio-facial portions</b>)</li><li>• Thin skull bones</li><li>• <math>\pm</math> Wide separation of sutures (<math>\uparrow</math>ICT in children)</li><li>• <math>\pm</math> Shunt operation</li></ul> | <ul style="list-style-type: none"><li>• <b>Absent sutures</b> (premature closure of sutures)</li><li>• Silver beaten appearance = finger prints</li><li>• Widening of sella turcica</li><li>• <math>\pm</math> Prominent anterior fontanel</li></ul>  |



| Filling defect(s) لونه إسود                       |                                                                                                                                                                                  |                                                                                                                                                                                                                                         |                                                                                                                                         |                                                                                                                                                | Filling defect(s) لونه أبيض                                                                                                                |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
|                                                   | Single filling defect                                                                                                                                                            | Miliary filling defect                                                                                                                                                                                                                  | Multiple filling defect                                                                                                                 |                                                                                                                                                | Osteosclerotic metastasis                                                                                                                  |
| View:<br>Plain<br>X-<br>Ray,<br>Skull,<br>lateral |                                                                                                 |                                                                                                                                                       |                                                      |                                                                                                                                                |                                                         |
| Description                                       | <b>Single rounded</b> filling defect for DD                                                                                                                                      | <ul style="list-style-type: none"> <li>Diffuse (miliary) pin point rounded filling defects giving rise to <b>salt &amp; pepper skull</b></li> </ul>  | 1. Multiple, rounded, <b>regular, well defined punched out (clearly cut), equal size</b> filling defects<br><br><b>Multiple myeloma</b> | 2. Multiple, rounded, <b>irregular, ill-defined ± bone erosion, variable size</b> filling defects<br><br><b>Multiple osteolytic metastasis</b> | Multiple hyperdensity (Osteosclerotic) lesions                                                                                             |
|                                                   | <b>❖ Single filling defect DD:</b> <ul style="list-style-type: none"> <li>Trephine operation</li> <li>Depressed fracture</li> <li><b>Single osteolytic metastasis</b></li> </ul> |                                                                                                                                                                                                                                         |                                                                                                                                         |                                                                                                                                                | <b>❖ Osteosclerotic metastasis from</b> <ul style="list-style-type: none"> <li>Prostate carcinoma ♂</li> <li>Breast carcinoma ♀</li> </ul> |
| Diagnosis                                         |                                                                                                                                                                                  | <b>Hyperparathyroidism</b>                                                                                                                                                                                                              |                                                                                                                                         |                                                                                                                                                |                                                                                                                                            |



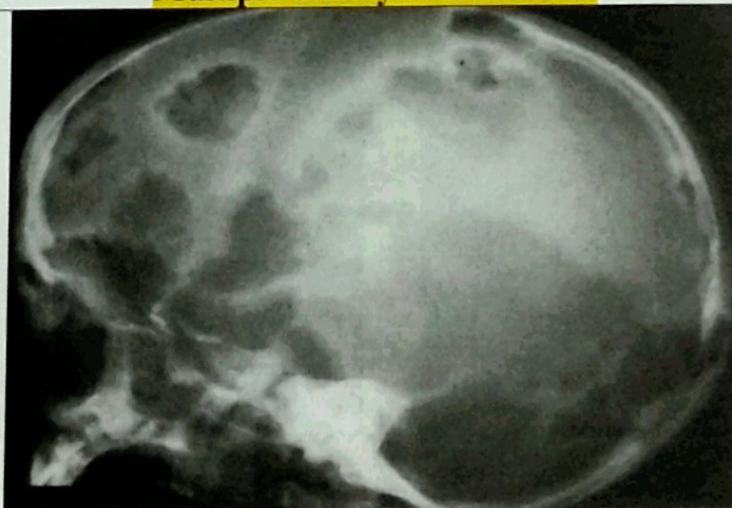
**Hyperparathyroidism**



**Multiple myeloma**



**Multiple osteolytic metastasis**

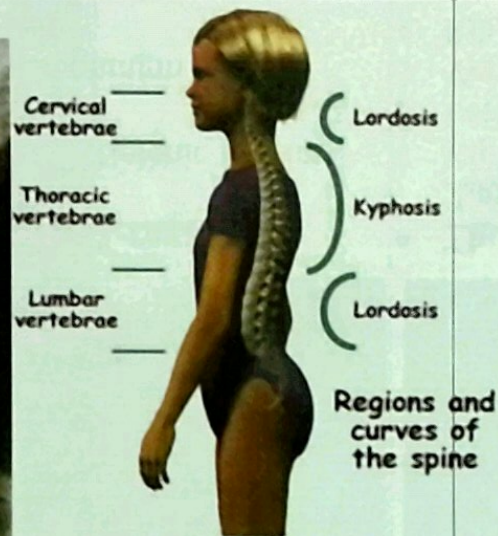




## Vertebral column -X-rays

### Normal Cervical Spine X-ray

#### Cervical



#### • Cervical Spine X-ray: AP view:

1. Clavicle.
2. 1st rib
3. Trachea.
4. Spinous process of C7
5. Vertebral Body of C5.
6. Uncinate process.

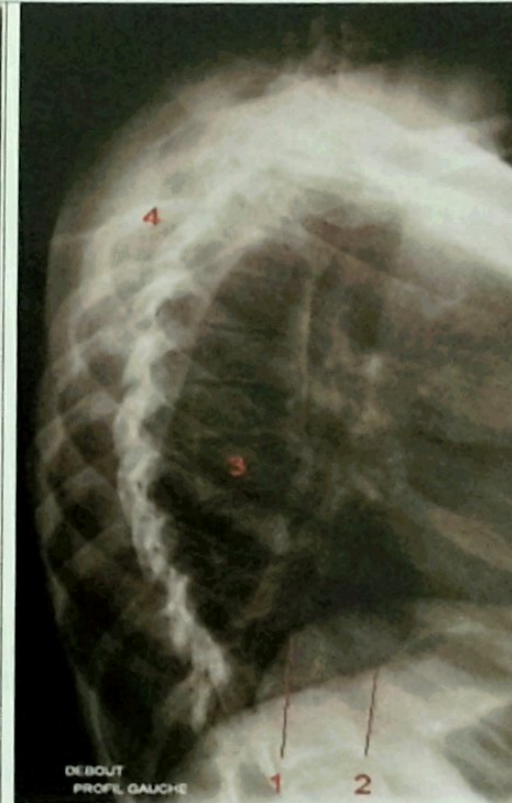
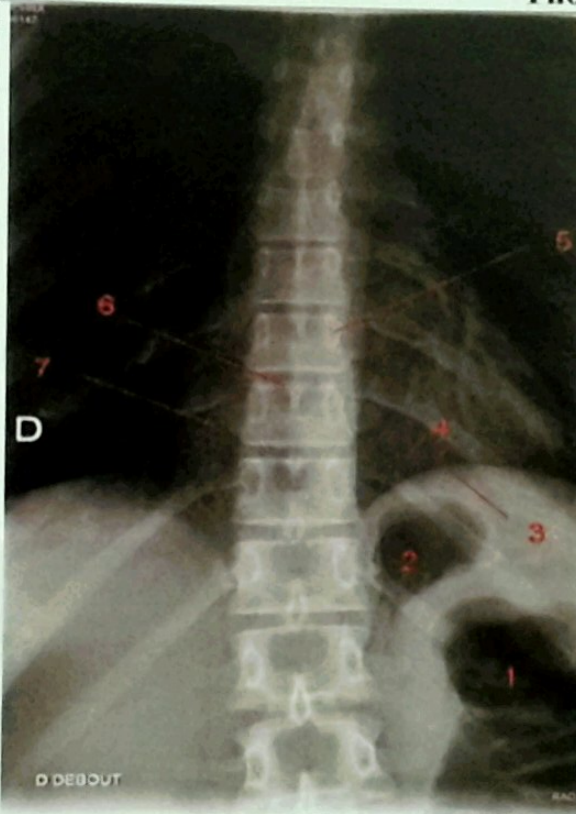
#### • Cervical spine X-ray : lateral view:

1. Vertebral body (TH1)
2. Spinous process of C7
3. Lamina
4. Inferior articular process
5. Superior articular process
6. Spinous process of C2
7. Odontoid process
8. Anterior arch of C1 (atlas)
9. Trachea



## Normal Thoracic Spine X-ray

### Thoracic



#### • Thoracic Spine X-ray

##### AP view:

1. Left ventricle
2. Gas in stomach.
3. Right hemidiaphragm.
4. Posterior rib
5. Clavicle.

#### • Thoracic Spine X-ray:

##### AP view :

1. Gas in Colon (Splenic flexure).
2. Gas in stomach
3. Left hemidiaphragm
4. Posterior rib
5. Pedicle
6. Spinous process
7. Transverse process.

#### • Thoracic Spine X-ray:

##### Lateral view:

1. Right hemidiaphragm
2. Left hemidiaphragm.
3. Vertebral body
4. Rib.

#### • Thoracic Spine X-ray: Lateral view:

1. Posterior rib
2. Vertebral body
3. Intervertebral discal space.



## Normal Lumbar Spine X-ray

### lumbar



- Lumbar spine x ray AP view:

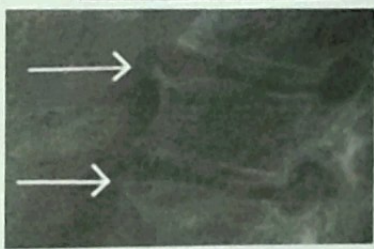
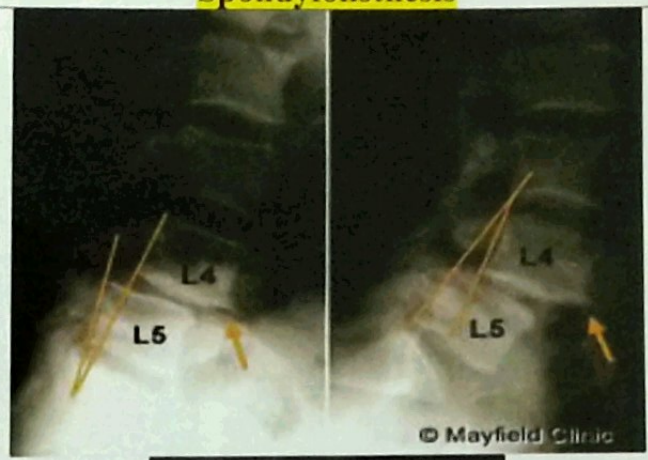
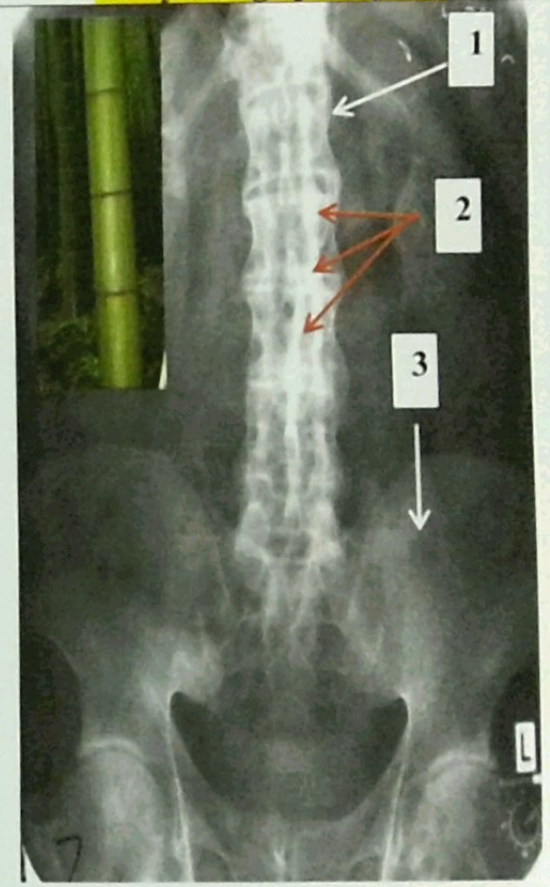
1. Rib
2. Transverse process
3. Pedicle
4. Spinous process
5. Sacrum
6. Sacroiliac joint



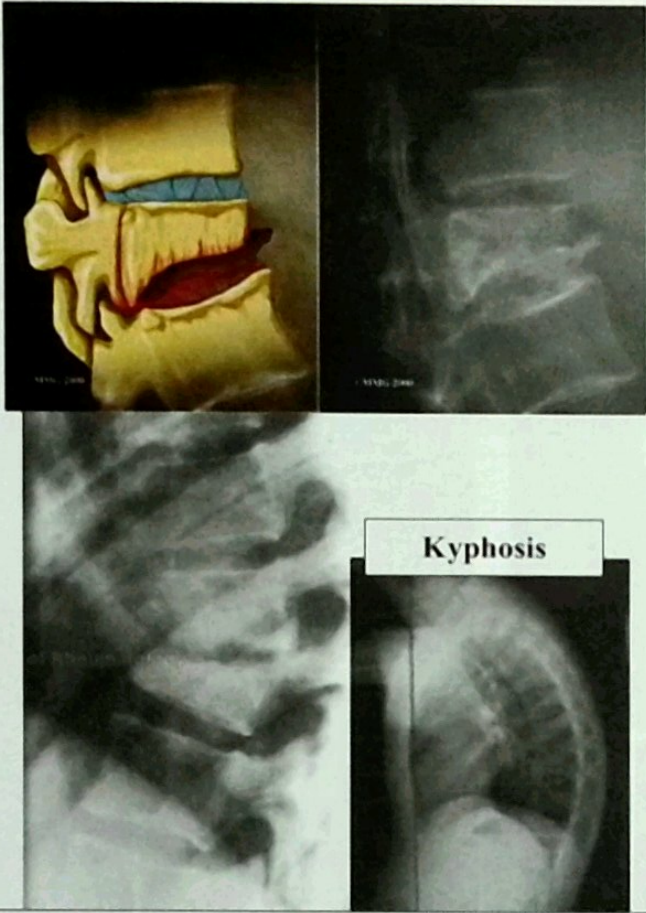
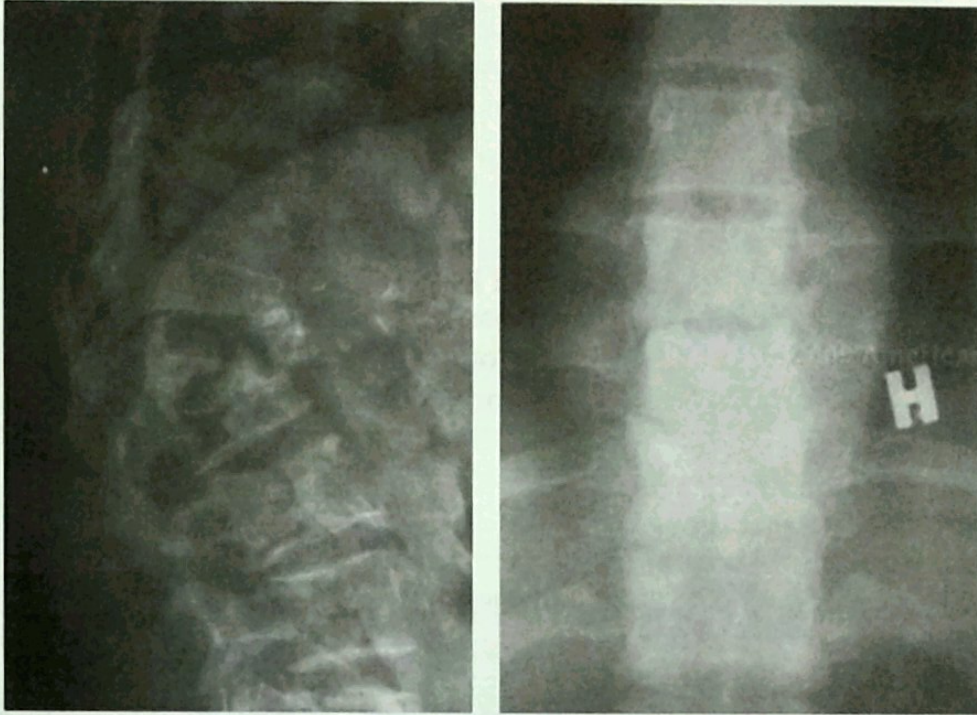
- Lumbar spine x ray , lateral view :

1. Sacrum
2. Spinous process
3. Vertebral body
4. Intervertebral disc space
5. Intervertebral foramina
6. Pedicle
7. Inferior articulating facet
8. Superior articulating facet
9. rib

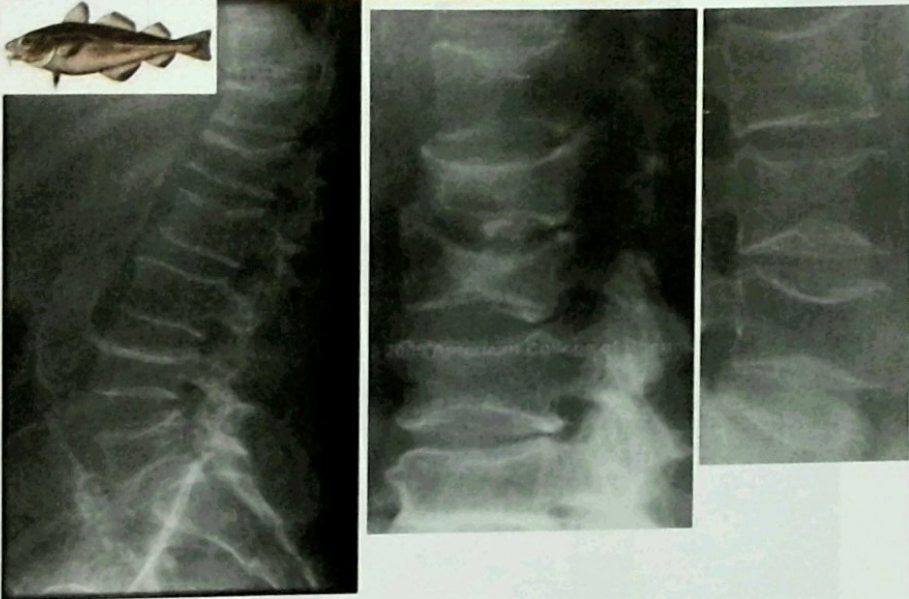
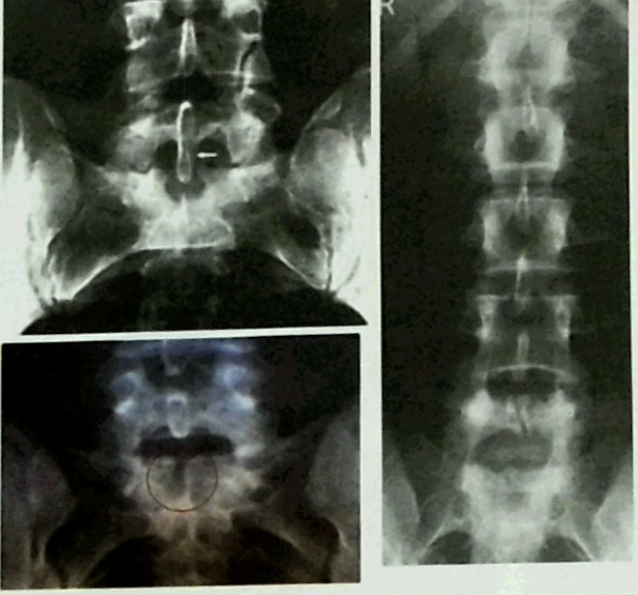


| Diagnosis   | Spondylosis                                                                                                                                                                                                                                                                                                                                                             | Spondylolisthesis                                                                                                                                                                                                                         | Ankylosing spondylitis                                                                                                                                                                                                                                                                     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                                                                                                                     |                                                                     |                                                                                                                                                                                                        |
| View        | Posteroanterior or lateral                                                                                                                                                                                                                                                                                                                                              | Plain X-Ray, Vertebral column, lateral                                                                                                                                                                                                    | Posteroanterior or lateral                                                                                                                                                                                                                                                                 |
| Description | <ul style="list-style-type: none"> <li>There are <b>osteophytes</b> (lipping)</li> <li>± Narrowed space(s)</li> <li>± Changes curvature : <ul style="list-style-type: none"> <li>- <b>Scoliosis</b> in PA view i.e. S shaped deformity of the spine or</li> <li>- <b>Loss of lordosis</b> in lateral view i.e. diminished curvature of the spine</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>Forward (Backward) <b>displacement</b> of vertebra ... over ...</li> <li>Commonest sites : <ul style="list-style-type: none"> <li>- L4 over L5 OR</li> <li>- L5 over sacrum</li> </ul> </li> </ul> | <ol style="list-style-type: none"> <li>1. Calcification of lateral longitudinal ligaments giving <b>bamboo spine</b>.</li> <li>2. ± Calcifications of posterior ligaments giving <b>dagger sign</b></li> <li>3. ± Obliteration of sacro-iliac joint space (<b>Sacroiliitis</b>)</li> </ol> |



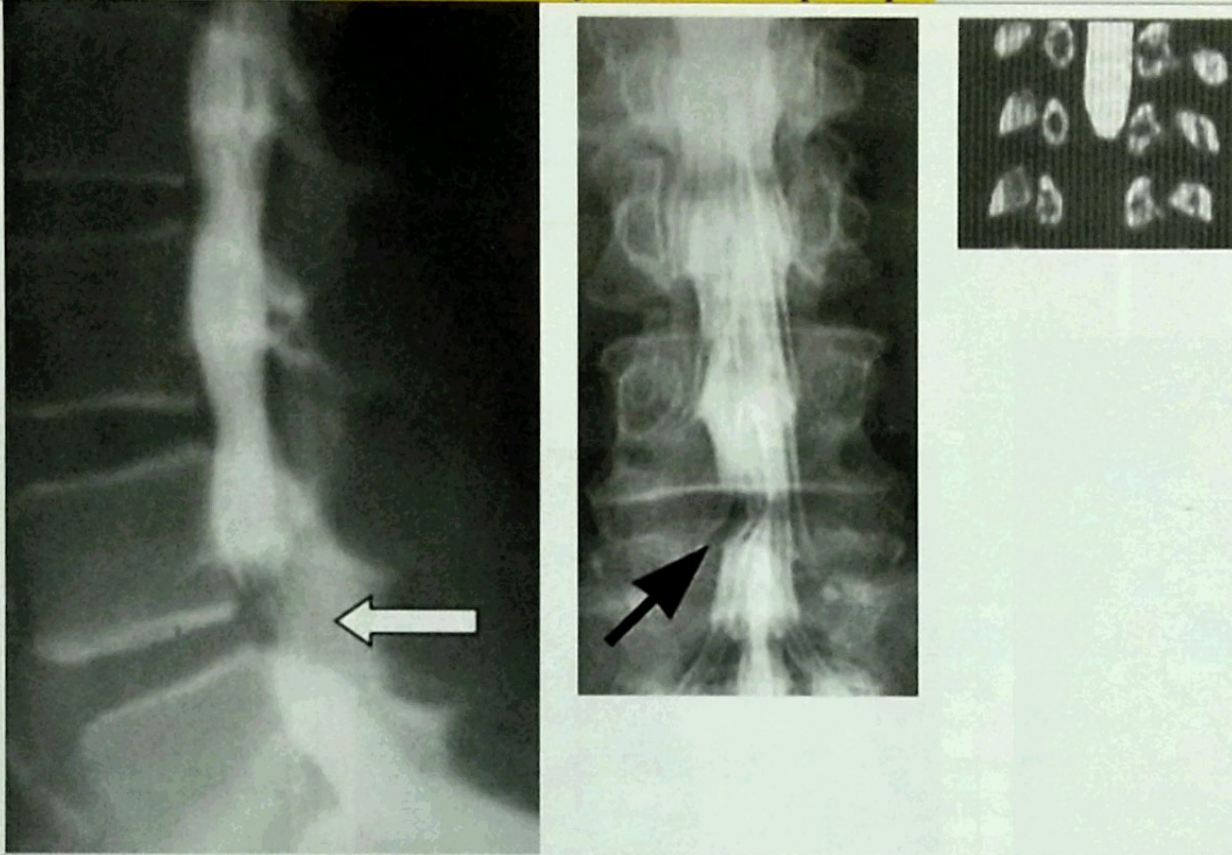
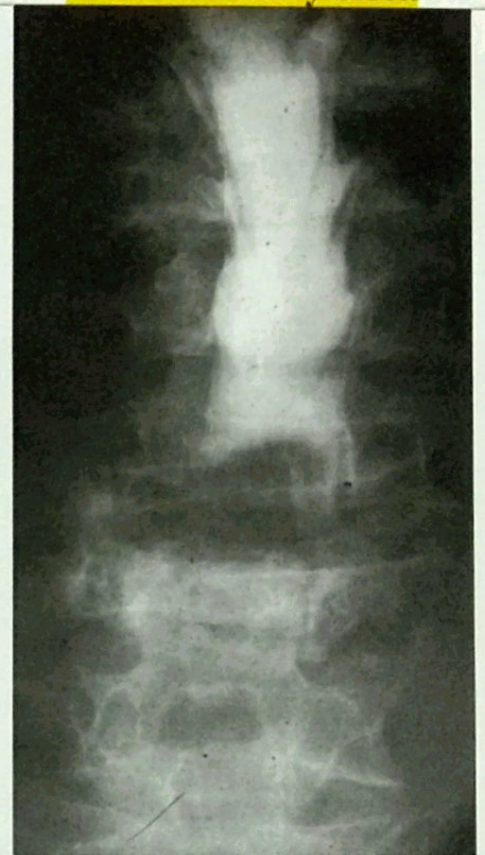
| Diagnosis   | Traumatic Fracture vertebra<br>(Compression Fracture)                                                                                                                                                                                                                                                                                           | Pathological Fracture vertebra<br>(most probably Pott's disease; TB)                                                                                                                                                                                                                                                                                     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |  <p>The images for Traumatic Fracture include an anatomical diagram of a vertebral body fracture, a lateral X-ray showing a compression fracture, and a sagittal X-ray with a label 'Kyphosis' pointing to an exaggerated forward curvature of the spine.</p> |  <p>The images for Pathological Fracture show two X-rays of the spine. The left image shows a vertebral fracture with a soft tissue shadow. The right image shows a vertebral fracture with a soft tissue shadow and a label 'H' pointing to a specific vertebra.</p> |
| View        | Plain X-Ray, Vertebral column, Posteroanterior or lateral                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |
| Description | <ul style="list-style-type: none"> <li>• <b>Fracture</b> of one vertebra</li> <li>• Normal density vertebra</li> <li>• Preserved disc space</li> <li>• Kyphosis ( exaggerated curvature of the spine )</li> </ul>                                                                                                                               | <ul style="list-style-type: none"> <li>• <b>Fracture</b> of more than one vertebra ( ... &amp; ... )</li> <li>• Rarified vertebrae</li> <li>• Narrowed disc space</li> <li>• Kyphosis</li> <li>• <math>\pm</math> soft tissue shadow (cold abscess)</li> </ul>                                                                                           |
|             | Fracture ... vertebra, most probably traumatic                                                                                                                                                                                                                                                                                                  | Fracture ( ... & ... ) vertebra, most probably Pott's disease (TB)                                                                                                                                                                                                                                                                                       |



| Osteoporosis of the spine                                                                                                                                                                                                                                                                                                                                                | Spina bifida                                                                                                                                                                                                                                          | Cervical rib                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                          |                                                                                                                                                                     |                                                                 |
| <p>Plain X-Ray,<br/>Vertebral column,<br/>Posteroanterior or lateral</p>                                                                                                                                                                                                                                                                                                 | <p>Plain X-Ray,<br/>Vertebral column,<br/>Posteroanterior</p>                                                                                                                                                                                         | <p>Plain X-Ray,<br/>Vertebral column,<br/>Posteroanterior</p>                                                                                      |
| <ul style="list-style-type: none"><li>• Generalized rarefaction of vertebral bodies (osteopenia)</li><li>• Biconcave vertebral outline = <b>cod fish spine</b></li><li>• ± Widened spaces</li><li>• ± Deformities ( specially Kyphosis)</li><li>• ± Pathological fracture.</li></ul>  | <ul style="list-style-type: none"><li>• <b>Bony defects</b> in the posterior portion of the neural arch i.e bifid spinous process ( spinous process not seen) due to failure of fusion of vertebral laminae posteriorly giving bifid spine.</li></ul> | <ul style="list-style-type: none"><li>• Short, thin , bilateral or unilateral , <b>additional rib</b> articulating with C7 instead of T1</li></ul> |



# Contrast = Myelogram

| Diagnosis   | Extra-medullary block = disc prolapse                                                                                                                                                                                                                     | Intra-medullary block                                                                                                                                             |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                                                                                                                                                                        |                                                                               |
| View        | Contrast X-ray on the vertebral spine ,<br>Posteroanterior or lateral                                                                                                                                                                                     | Contrast X-ray on the vertebral spine ,<br>Posteroanterior                                                                                                        |
| Description | <ul style="list-style-type: none"> <li>• <b>Interruption</b> (or indentation or complete arrest ) of dye at disc between ... &amp; ...</li> <li>- Commonest site : space between L4 &amp; L5</li> <li>• ± Narrow space</li> <li>• Saddle shape</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Central filling defect</b> (localized ballooning) with thin tails on either side</li> <li>• Fusiform shape</li> </ul> |



## GIT & UROLOGY

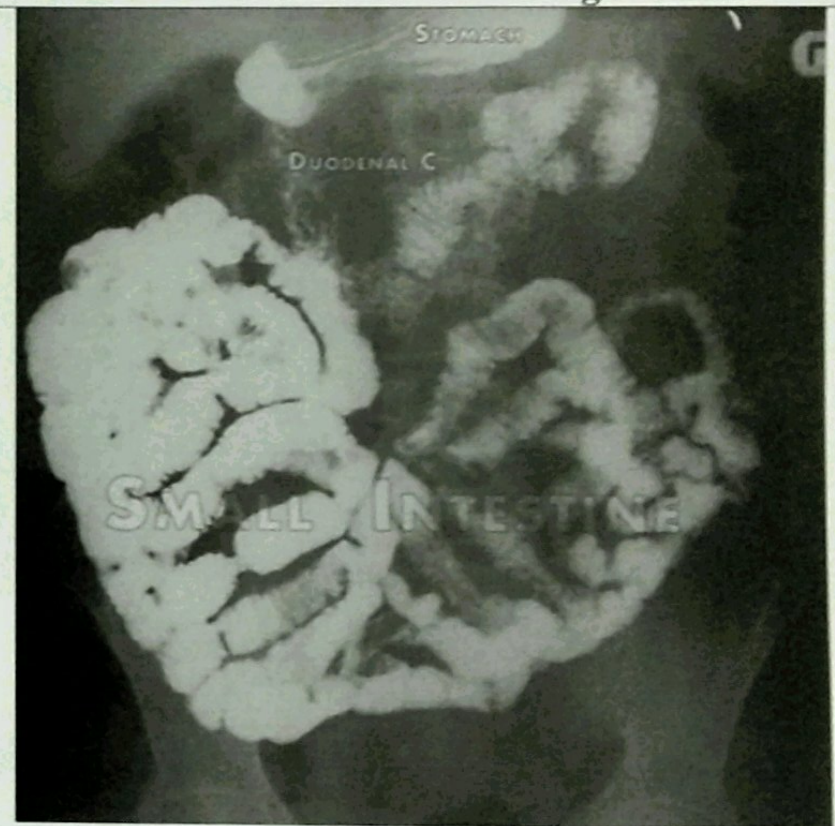
Normal barium swallow



Normal barium meal



Normal follow through

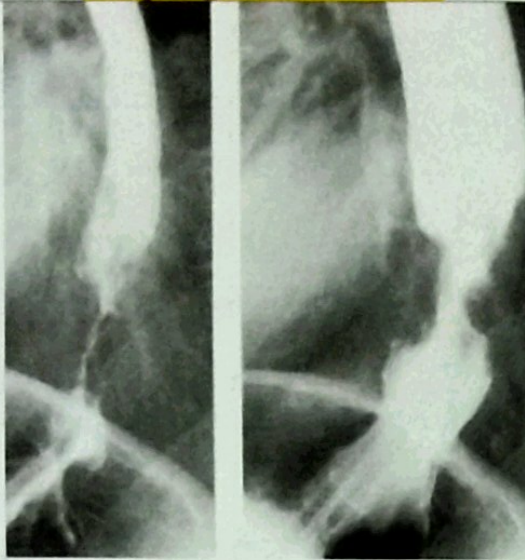




## A-Contrast X-Rays

### I-Barium swallow = Oesophagus

#### Esophageal carcinoma



- Persistent irregular filling defect with shouldering or rat tail appearance.
- Usually in the middle of 1/3 of esophagus
- **No** marked proximal dilatation.

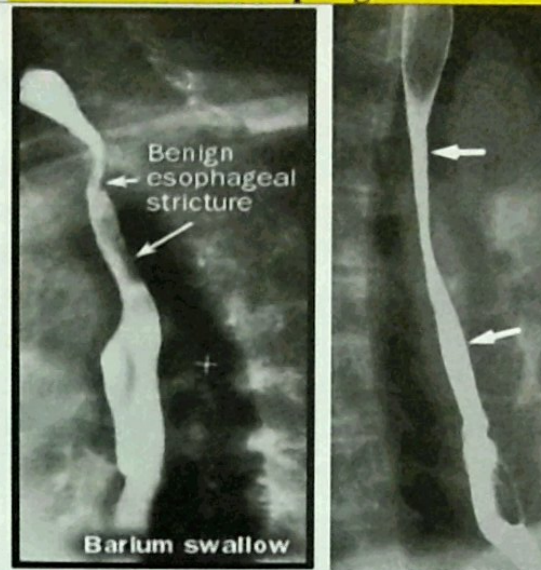


#### Achalasia of the cardia



- Smooth narrowing of the lower end of the esophagus (Hen's peak or Parrot's peak)
- At the level or just below diaphragm
- **Marked dilatation** with a fluid level
- No gas bubble in the fundus of the stomach.

#### Post corrosive esophageal stricture



- Smooth, long, multiple strictures
- Usually at T4 & the two ends of the esophagus.
- No marked dilatation above the strictured segment.

#### Esophageal varices

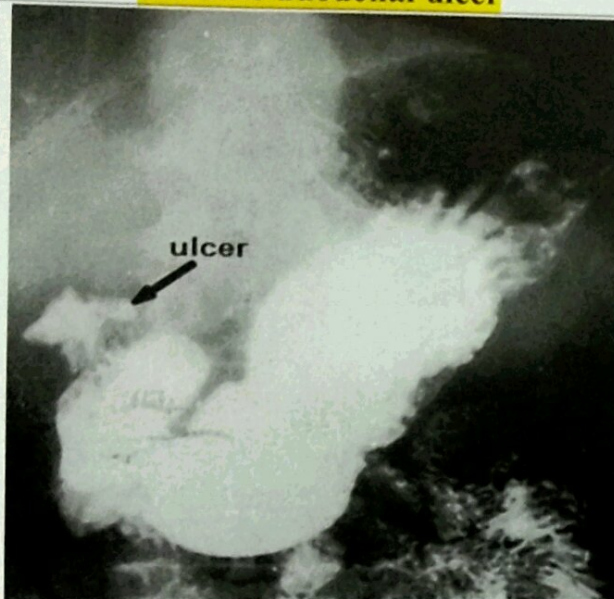


- Multiple smooth rounded & longitudinal filling defects
- Starting from lower 1/3 of the esophagus,

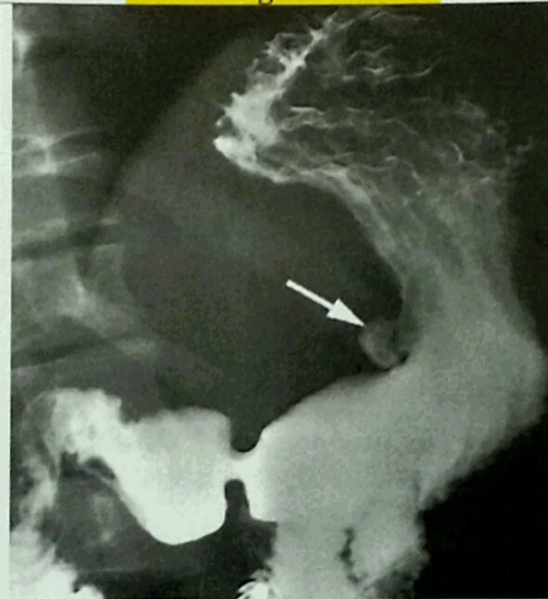


## II-Barium meal = stomach & duodenum

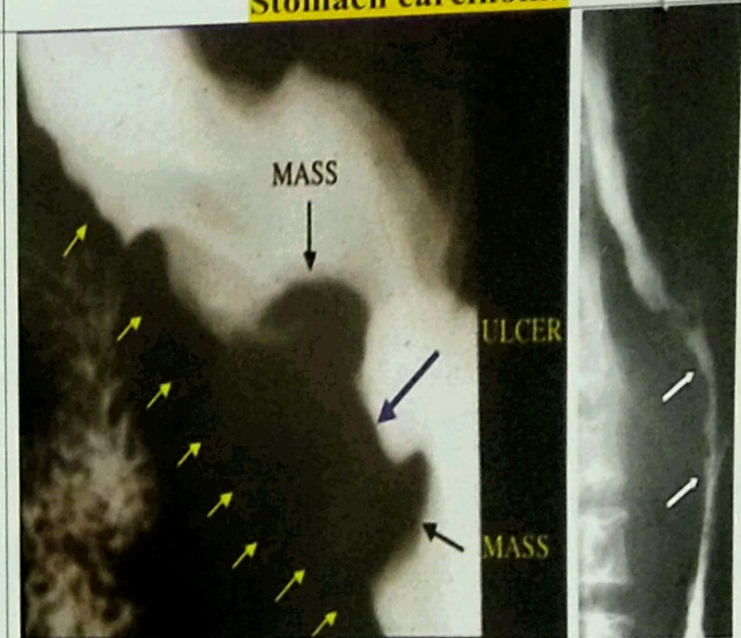
**Chronic duodenal ulcer**



**Chronic gastric ulcer**



**Stomach carcinoma**



❖ Barium meal show one or more of the following :

- **Ulcer niche full of barium in duodenal cap**

- Persistent deformity of duodenal cap in **serial study** due to spasm and later fibrosis
- NB : an example for common deformity is **trifoliate deformity**



- **Stomach is steer horn (hypertonic)**



- **Ulcer niche full of barium usually on lesser curvature** and projects to outside the stomach

- Notch on greater curvature opposite the ulcer niche appears as smooth filling defects due to spasm and later fibrosis of circular muscle fibers

- **Stomach is J shaped (hypotonic)**

- If it presents as a **mass**, it will be as persistent irregular filling defect.
- If it presents as a **malignant ulcer**, it will be in the antrum or greater curvature
- **Linitis plastic : leather bottle stomach** marked narrowing of the lumen of the stomach due to diffuse carcinoma of the stomach converting it into narrow irregular tube but the flow of barium is not interrupted





### Congenital hypertrophic pyloric stenosis



- The pyloric canal is very thin, prolonged (**string sign**)
- The duodenal cap is **umbrella shaped**.
- Delayed gastric emptying

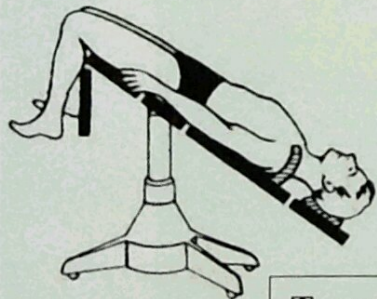
### Chronic pyloric obstruction



- There is huge **proximal dilatation** of the stomach till the pelvis giving the picture of **soup-dish or soup-plate appearance**
- Wide smooth antrum

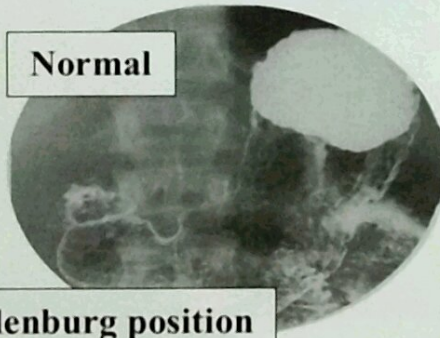
### Sliding hiatus hernia

- Barium meal in Trendelenburg's position, Barium at the fundus of the stomach
- The esophagus is opacified (reflux), **Epiphrenic bulge** (part of stomach is seen above the diaphragm)



Trendelenburg position

Normal



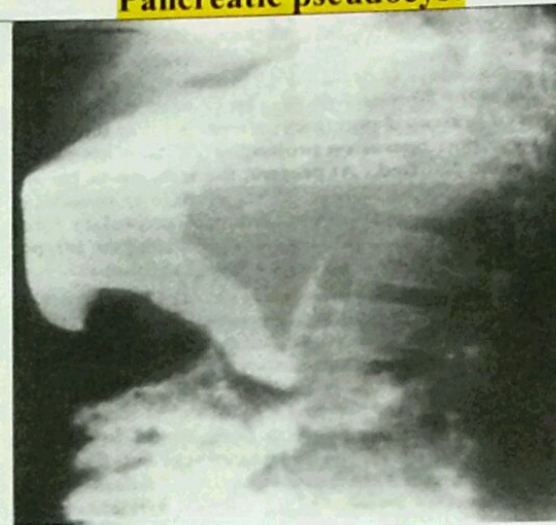


### Carcinoma of the head of pancreas



- **Wide C curve of the duodenum** (normally doesn't exceed one vertebra)

### Pancreatic pseudocyst

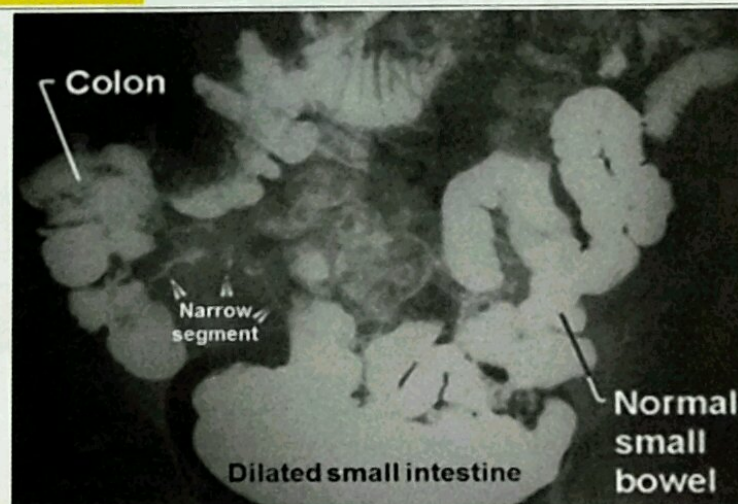


- **Displacement and compression of the stomach**

## III-Barium follow through = small intestine

### Crohn's disease

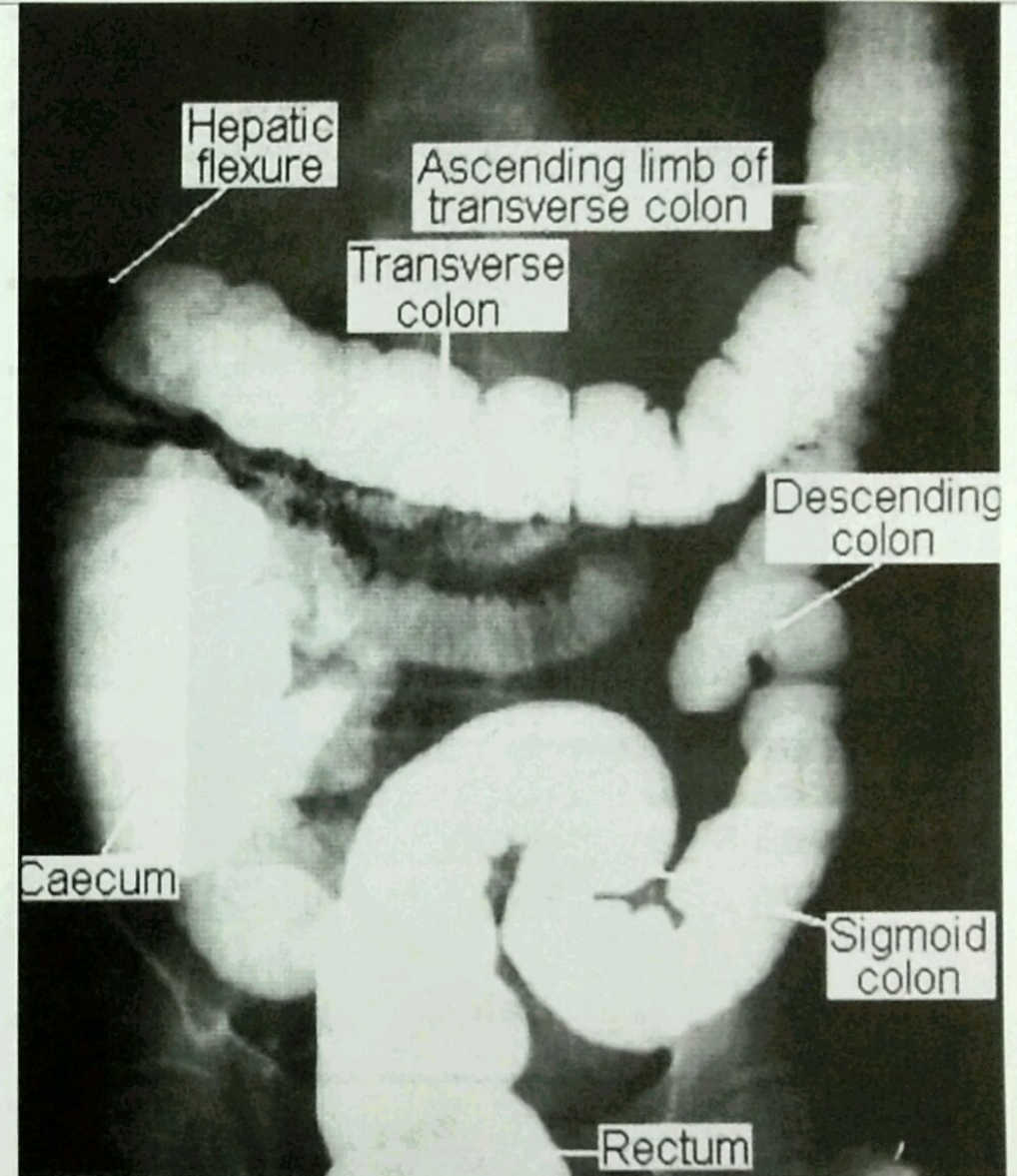
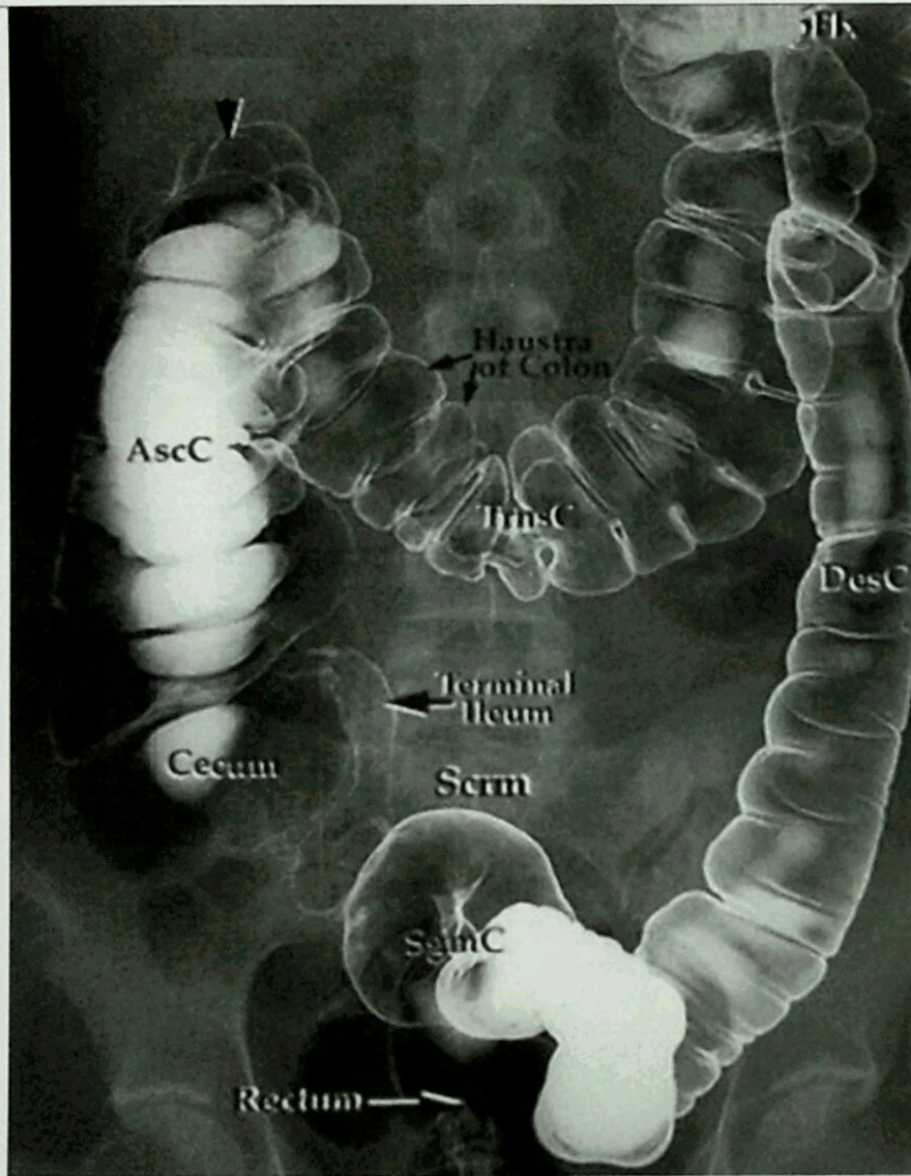
- ❖ May show one or more of the following :
  - Site : **terminal ileum** is the most commonly affected site
  - **Segmental areas of narrow irregular stricture**
  - Cobble stone appearance of the mucosa caused by ulceration of mucous membrane with edema of intervening mucosa
  - Internal or external fistulae
  - Polyps may be seen
  - **Skip lesions:** areas of normal bowel between the lesions
  - The finding of narrowed terminal ileum segment is known as the **string sign of Kantor**





# IV-Barium enema = colon

## Normal barium enema





### Colon carcinoma



- Fixed irregular filling defect.
- Annular strictures of the left colon show characteristic “shouldering with apple core appearance”



### Ulcerative colitis



- **Rectum** with or without variable segments of the colon are affected
- Wide spread ulcers with “granular or ground ulcer appearance”
- **Loss of haustrations**
- Narrowing, shortening of colon → **Pipe stem appearance**
- Polyps may be seen
- No skip lesion
- The terminal ileum not affected





### Polypoid coli



- Types : bilharzial, familial or Gardner's syndrome
- **Multiple rounded filling defects**
- In Bilharziasis it is usually limited to sigmoid colon
- In familial polyposis it affects the whole colon

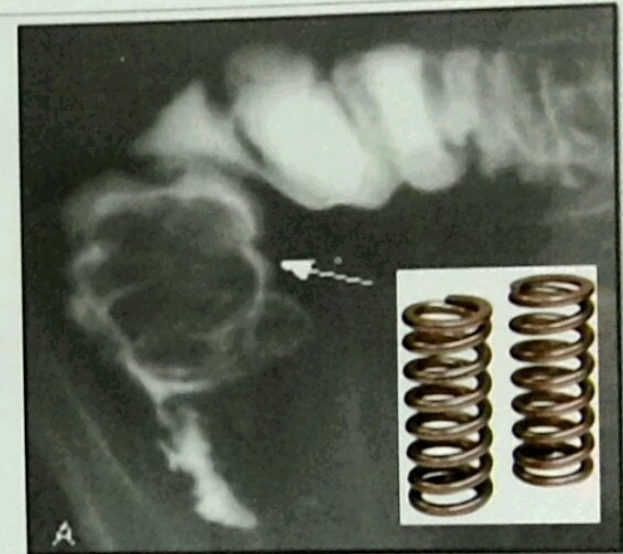
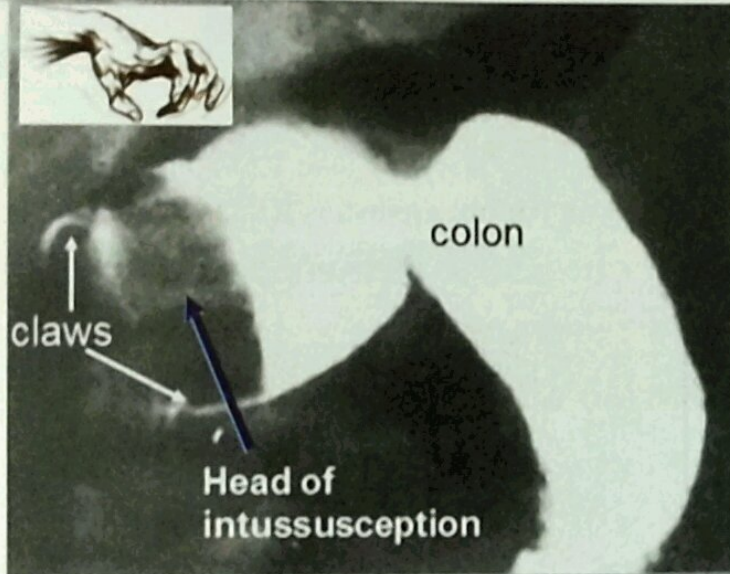
### Diverticular disease of the colon "Diverticulosis"



- ❖ It may show one or more of the following :
  - In the prediverticular stage : A **saw teeth appearance** of the colon.
  - Then fully developed diverticulae will be visualized as **protrusions full of barium**
  - Fistulae as colo-vesical or colo-vaginal fistula may develop as a complications.



### Intussusception



- The barium will fill the colon until it stops at the area of intussusception where a cylindrical filling defect appears and there is arrest of further progress of contrast ( **claw sign or meniscus sign & coiled spring sign** )

### V- Oral cholecystography

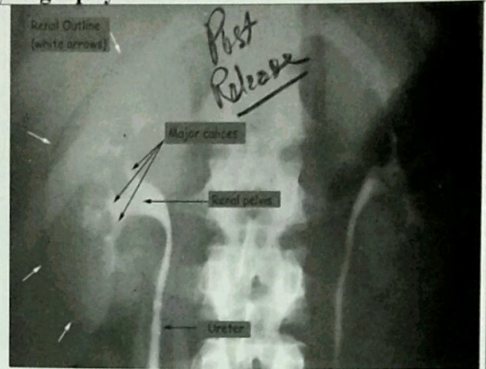


- Now it has been nearly replaced by ultrasonography
- Method :**
  - The patient fasts for 12 hours before the examination and swallows 6 tablets of telepaque (tetraiodophenolphthalin)
  - The contrast material is absorbed, secreted by the liver in the bile and passes via cystic duct to be concentrated in the gall bladder
- Normally the gall bladder will be well opacified
- Radiolucent stones will appear as filling defects**



## VI- Pyelography

### Normal Pyelography



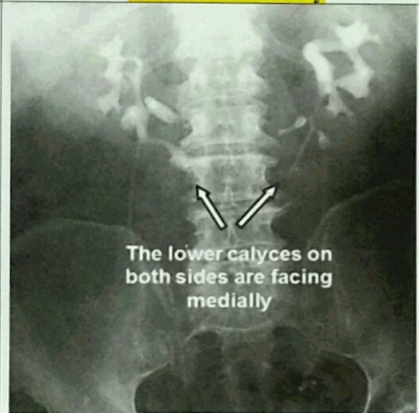
#### Types :

- Descending = intravenous pyelogram , Ascending = retrograde pyelography

#### Double pelvis, double ureter



#### Horse shoe kidney



- Duplex collecting systems can be unilateral or bilateral
- **The kidney has 2 pelvi-calyceal systems & 2 ureter.**
- Could be either :
  - **Incomplete duplication** : both ureters join in the lower third of their course or
  - **Complete duplication** : both ureters opening separately into the bladder

- The pelvis arises from the **anterior** aspect of the kidney
- Lower pole calyces point **medially**
- The pelvi-calyceal system lies at **lower** level
- The pelvi-calyceal system is closer to the **midline**
- The ureters lie on the body of vertebrae, not on transverse processes



### Ectopic kidney



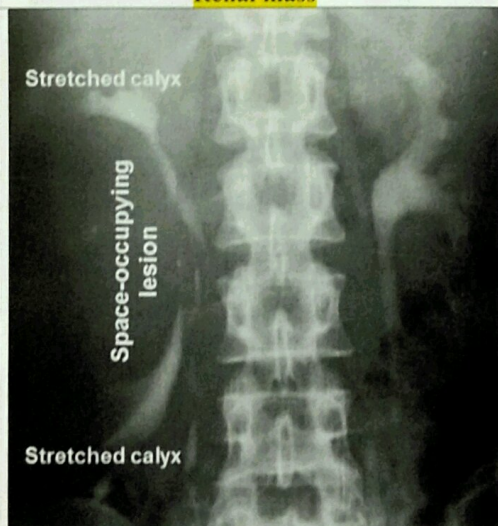
### Crossed renal ectopia



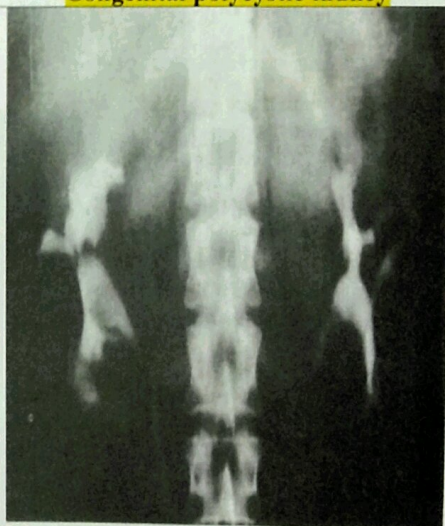
- Ectopic kidney is a **low placed kidney with straight ureter** and some calyces will face medially (malrotated)
- **D.D. ptosed kidney** : a low placed kidney with tortuous ureter and all calyces are facing laterally

- **Location of the kidney on the contralateral side in respect to the ureteral orifice location at the bladder**

### Renal mass



### Congenital polycystic kidney

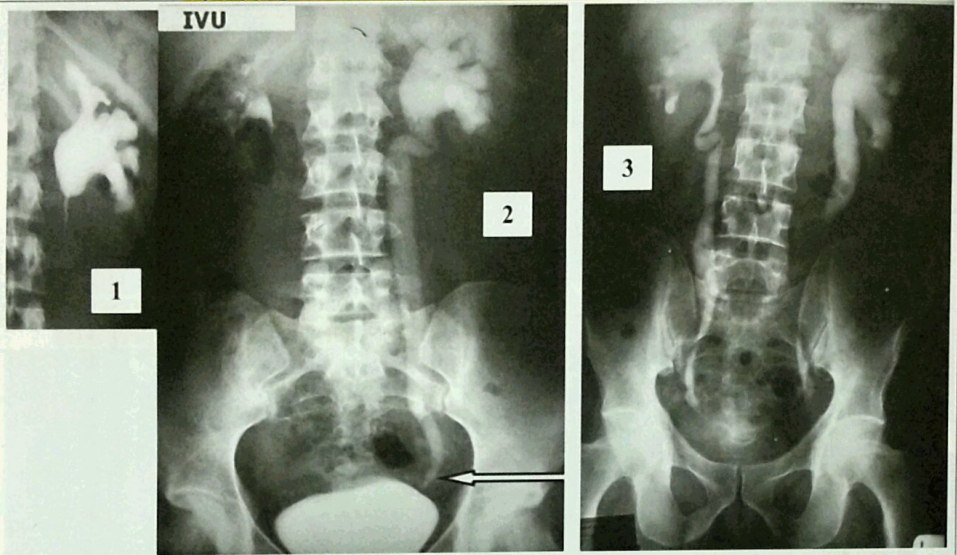


- **Unilateral** displacement of pelvi-calyceal system showing **spider leg appearance or amputated pelvi-calyceal system**
- In adults : mostly hypernephroma
- In children : mostly Wilm's tumor

- The calyces are stretched over the cysts giving the **bilateral spider leg appearance; elongation, narrowing, stretch and wide separation of calyces.**



### Hydronephrosis & hydroureter (unilateral or bilateral)



- **Dilated** pelvi-calyceal system & ureter
- There is **deformed** smooth curve between the lower border of lower calyx, renal pelvis and ureter
- There is loss of waist, flattening, clubbing and **ballooning of minor calyces**
- **Comment on :**
  - Unilateral or bilateral
  - Is the other kidney functioning or not .
  - Site of obstruction :
- 1. **Unilateral hydronephrosis :** pelvi-ureteric junction obstruction
- 2. **Unilateral hydronephrosis & hydroureter :** lower ureteric obstruction (stones or stricture)
- 3. **Bilateral hydronephrosis & hydroureter :** bladder neck obstruction or bilateral lower ureteric obstruction

### Non- visualization of one kidney

#### ❖ Non- visualization of one kidney for DD :

- Congenitally absent
- Surgically removed (nephrectomy)
- Non functioning
- $\pm$  reflexly inhibited by a recent attack of renal colic





## VII- Cystography

### Normal cystography



- **Types :** Descending : no urethral catheter OR Ascending : urethral catheter present

### Bladder diverticulum

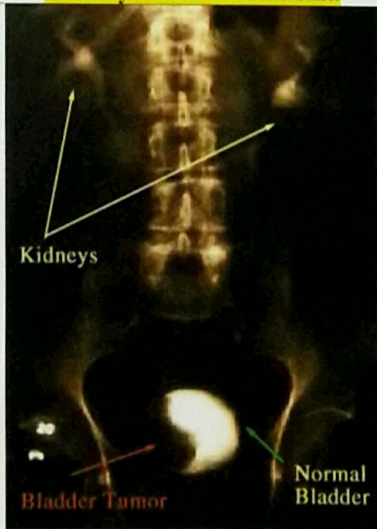


### Benign prostatic hyperplasia



- The cystography will show bladder diverticulae as **out pouching of the dye**

### Urinary bladder carcinoma



- **Smooth basal filling defect** in the bladder raising the bladder shadow above the symphysis pubis
- There may be sacculation in the wall of the bladder or actual diverticulae
- Hydronephrotic changes of the kidneys

**Irregular filling defects in the lateral part** of UB



**Bladder diverticulum**



**Benign prostatic hyperplasia**



**Urinary bladder carcinoma**



**BPH & bladder diverticulum**



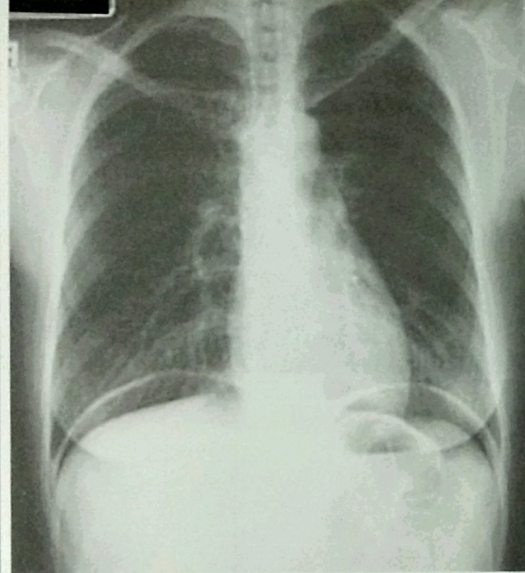


## B-Plain X-Rays

I-Black shadow = air

Pneumoperitoneum , upright (erect) position

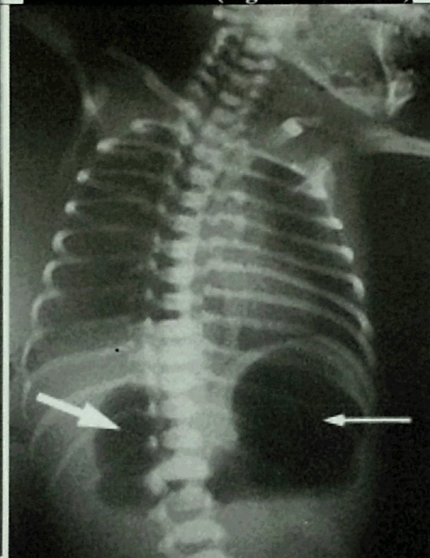
EMBBS



- Free air (hypertranslucent) in the peritoneal space under the diaphragm above the stomach on the left side and liver on the right side.
- The most common cause is perforated peptic ulcer.

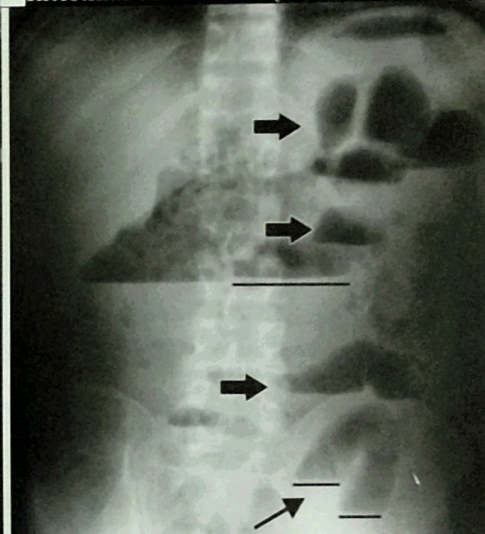
Bowel Obstruction ,upright(erect) position

Duodenal atresia (high obstruction)



- The abdomen is distended by two air and fluid levels (double bubble sign)
- No other gases are seen on the abdomen

Intestinal obstruction (low obstruction)



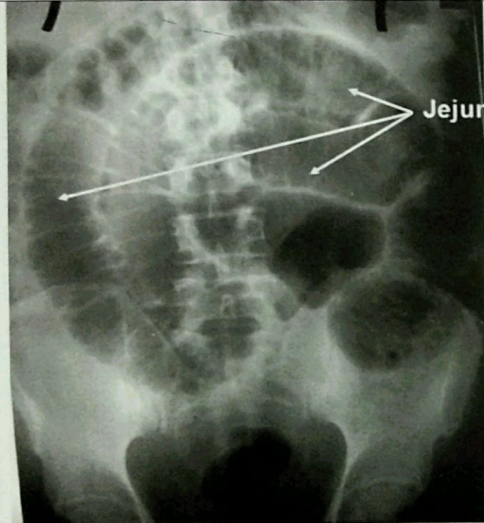
- The abdomen is distended by multiple gas and fluid levels
- Distended intestinal loops



# **Bowel Obstruction , supine position** = dilatation of the bowel

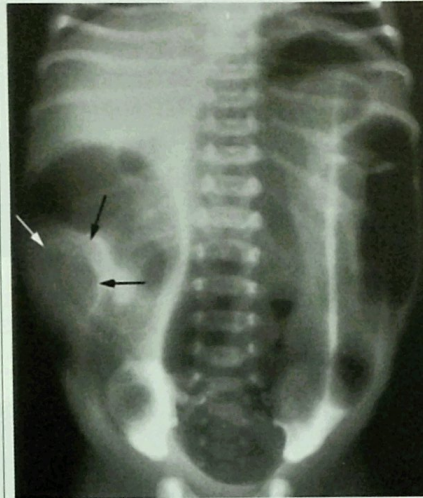
- Identification of the level of intestinal obstruction from pattern of the distended bowel loops

## **Small intestine obstruction at level of jejunum**



- Distended jejunal loops show the characteristic circular mucosal folds (**valvulae conniventes**) **crossing** from one side of the lumen to the other and are equally spaced.

## **Small intestine obstruction at level of ileum**



- Distended ileal loops appear as **structureless tubes** with no mucosal pattern

## **Large intestine obstruction**



- A colon full of gas shows **haustration** that **do not reach the other side** of the lumen,



## II- Radio-opaque foreign body e.g. swallowed or surgically implanted.

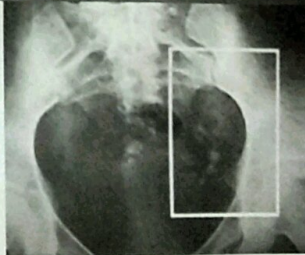


## III- Radio-opaque stones : describe (site, size & shape)

### Kidney stone



### Ureter stone



- In the right or left hypochondrium opposite T12,L1,2,3

- Oval, along tips of transverse processes of lumbar vertebrae.
- On ala of the sacrum
- On side wall of pelvis



### Urinary bladder stone



- In the midline, suprapubic

### Anterior urethral stone (bulbous & penile)



- Below the level of symphysis pubis

### Posterior urethral stone (prostatic & membranous)



- Behind the symphysis pubis in the midline

### Gall bladder stone



- Any **opaque shadow in the right hypochondrium** (Antero-Posterior view) needs lateral view to differentiate right kidney stone from gall bladder stone
- **In lateral view :**
  - Gall bladder stones → in front of the spine
  - Kidney stones → on the spine
- Only 10 % of gall bladder stones are radiopaque and the majority is radiolucent.

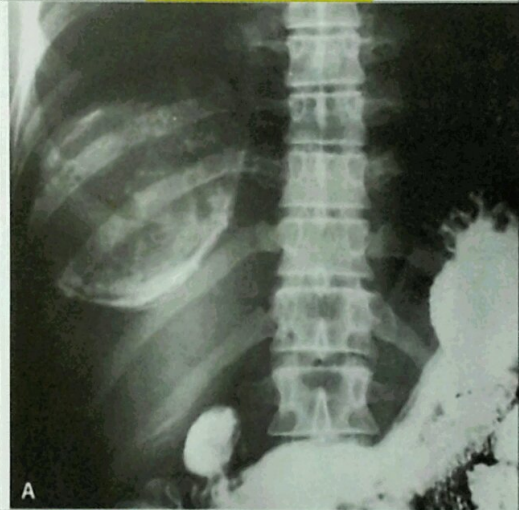


#### IV- Calcifications :

- **Organ :**

- Anatomical site
- Pattern of calcifications :
  - Solid organ : mottling or dotting
  - Hollow organ : linear = organ boundaries

##### Calcification in liver



- **Causes :** hydatid cyst , abscess , hepatoma

##### Calcified kidney = nephrocalcinosis



- **Causes :** TB , pyonephrosis

##### Calcification in spleen



- **Causes:** Splenic infarction , hydatid cyst

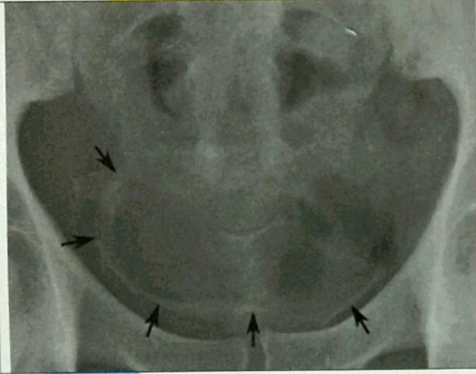
##### Calcified pancreas



- **Cause:** chronic pancreatitis



### Calcified Urinary bladder



- **Causes :** Bilharzial calcification , eaten calcification in urinary bladder (squamous cell carcinoma)

### Calcified Prostate



- **Causes :** Bilharzial calcification , TB

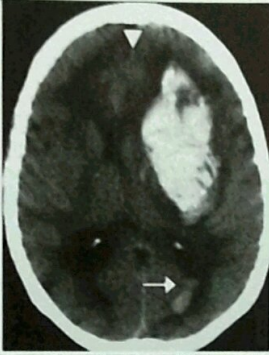
### Calcified mesenteric lymph nodes= Tabes mesenterica



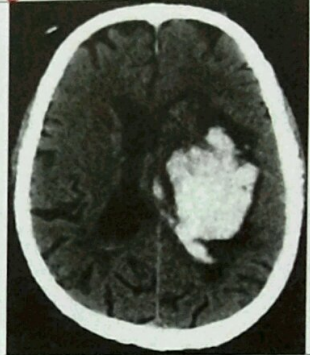
التيه يترحمون بالدموع يحصدون بالابتهاح  
انظروا إلى الأجيال القديمة وتأملوا. هل توكك أحد على الرب فنجزي؟  
الذي بدأ معك اول الطريق له يتركت في منتصفه  
هو شايه هو عارف مش ينسى ☺



## CT Scan : Hemorrhage



- Plain CT scan of head
- Ventricular level (lateral ventricular horns & 3<sup>rd</sup> ventricle)
- **Hyperdense lesion in the cerebral substance** in the left temporo-parietal area with mass effect (compression of the left lateral ventricle)
- There is intraventricular extension of hemorrhage (arrow)
- **Diagnosis : intracerebral hematoma**



- Plain CT scan of head
- Ventricular level (bodies of lateral ventricle)
- **Hyperdense** area affecting the left **ventricle** with ventricular dilatation
- **Diagnosis : intraventricular hematoma + acquired obstructive hydrocephalus**



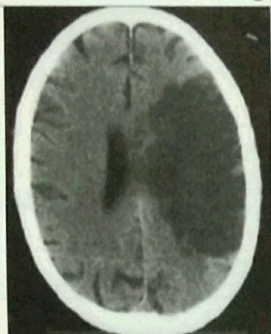
- Plain CT scan of head
- Ventricular level (bodies of lateral ventricle)
- **Hyperdense biconvex** lesion affecting right fronto-parietal region (white arrow) with mass effect (compression of right ventricle)
- With left temporal fracture producing another epidural hematoma and extracranial hematoma
- **Diagnosis : epidural hematoma.**



- Plain CT scan of head
- Ventricular level (bodies of lateral ventricle)
- **Hyperdense concavo-convex lesion**, affecting left fronto-parietal region with mass effect (compression of the left lateral ventricle)
- **Diagnosis : subdural hematoma.**



## CT Scan : Miscellaneous



- Plain CT scan of head
- Ventricular level (bodies of lateral ventricle )
- **Hypodense** localized area in the left frontoparietal region with mass effect (compression of the left lateral ventricle ) with normal right lateral ventricle.
- **Diagnosis : localized infarction in the frontoparietal region**



- **Contrast enhanced CT**
- Ventricular level (bodies of lateral ventricle)
- Small **hypodense** area with ring enhancement of abscess capsule in the left fronto-parietal region
- **Diagnosis : single small brain abscess**



- Plain CT scan of the head
- Ventricle level (bodies of lateral ventricle)
- **Increased prominence** of cerebral sulci , interhemispheric fissure, ventricular dilatation ( passive dilatation due to reduced cerebral mass)
- **Diagnosis : brain atrophy**



- Plain CT scan of head
- Infratentorial level (posterior fossa)
- **Diffuse brain hypodensity** with loss of grey white interphase & loss of infratentorial spaces
- **Diagnosis : brain edema ( loss of CSF spaces)**



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## BLOOD

### ➤ Normal blood values :

| 1. <b>Red blood cell parameters</b> : variable according to age & sex |                                                                                                                                                                                                                                                                                                                                                |                              |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Item                                                                  | Value                                                                                                                                                                                                                                                                                                                                          | Average                      |
| <b>RBCs</b>                                                           | <ul style="list-style-type: none"> <li>♂ = <math>4.5 - 5.5 \times 10^{12} / L</math></li> <li>♀ = <math>3.8 - 4.8 \times 10^{12} / L</math></li> <li>↑ = polycythemia , ↓ = anemia</li> </ul>                                                                                                                                                  | 5                            |
| <b>Hemoglobin(Hb)</b>                                                 | <ul style="list-style-type: none"> <li>♂ = 13 – 17 g/dl</li> <li>♀ = 12 – 16 g/dl</li> <li>Anemia = decreased Hb content</li> </ul>                                                                                                                                                                                                            | 15                           |
| <b>Colour index</b>                                                   | <ul style="list-style-type: none"> <li>C.I = <math>HB\% \div RBC\% = 100 \div 100 = 1</math></li> <li>- C.I. &lt; 0.9 = microcytic hypochromic anemia</li> <li>- C.I. = 1 = normocytic normochromic anemia</li> <li>- C.I. &gt; 1.1 = macrocytic anemia</li> <li>• NB : CI is non-reliable as there are no absolute numbers (only%)</li> </ul> | 1                            |
| <b>Packed cell volume (PCV) or hematocrite value</b>                  | <ul style="list-style-type: none"> <li>♂ = 40 – 50 %</li> <li>♀ = 35 – 45 %</li> <li>• It is the volume of packed red cells in relation to the total volume of blood</li> <li>• It increases in polycythemia – dehydration</li> <li>• It decreases in anemia – overhydration</li> </ul>                                                        | 45 %                         |
| <b>Mean corpuscular volume (MCV)</b>                                  | <ul style="list-style-type: none"> <li>• Normal = 78 – 98 fl</li> <li>• In anemia :                             <ul style="list-style-type: none"> <li>- &lt; 78 : microcytic anemia</li> <li>- 78 – 98 : normocytic anemia</li> <li>- &gt; 98 : macrocytic anemia</li> </ul> </li> </ul>                                                      | 90 femtoliter = Cubic micron |
| <b>Mean corpuscular hemoglobin(MCH)</b>                               | <ul style="list-style-type: none"> <li>• Normally : 27-32 pg</li> </ul>                                                                                                                                                                                                                                                                        | 30                           |
| <b>Mean corpuscular hemoglobin concentration</b>                      | <ul style="list-style-type: none"> <li>• Normally : 32-35 g/dl</li> <li>• In anemia :                             <ul style="list-style-type: none"> <li>- &lt; 32 : hypochromic anemia</li> <li>- 32-35 : normochromic anemia</li> <li>- &gt; 35 : hyperchromic anemia</li> </ul> </li> </ul>                                                 | 34 %                         |
| <b>Red cell distribution width</b>                                    | <ul style="list-style-type: none"> <li>- RDW = Normally : 11.5 – 14.5 %</li> </ul>                                                                                                                                                                                                                                                             |                              |
| <b>Reticulocytes</b>                                                  | <ul style="list-style-type: none"> <li>- Normally represent 0.5-2 % of RBC concentration</li> </ul>                                                                                                                                                                                                                                            |                              |

2. **Osmotic fragility**: hemolysis of RBC begins at 0.45 and ends at 0.33 gm % NaCl.

3. **Size** : diameter of RBC = 7.2 micron

- Marked variation in size = anisocytosis
- Microcyte < 6.7 micron
- Macrocyte > 8 micron
- Megalocytes > 12 micron

**NB: Units :**

- Milli =  $10^{-3}$
- Micro =  $10^{-6}$
- Nano =  $10^{-9}$
- Pico =  $10^{-12}$
- Femto =  $10^{-15}$



#### 4. **Shape** : rounded biconcave disc

##### • Abnormally :

| shape  | Target cell                                                                   | Spherocytes                   | Sickle cells         |
|--------|-------------------------------------------------------------------------------|-------------------------------|----------------------|
| Causes | Anemia :<br>- Thalassemia<br>- Sickle cell anemia<br>- Iron deficiency anemia | - Hereditary spherocytosis    | - Sickle cell anemia |
|        | Liver<br>- Obstructive jaundice<br>- Liver disease                            | - Autoimmune hemolytic anemia |                      |
|        | After splenectomy                                                             | - Blood transfusion           |                      |
| NB:    | Poikilocytosis : red cells are variable in shape .                            |                               |                      |

#### 5. **Reticulocytes** :

##### - RBCS development :

Normoblast (never in peripheral blood) → reticulocyte (0.5-2%) → erythrocyte (RBC)

- Normally represent 0.5-2 % of RBC concentration
- It is the cell which remains after extrusion of the nucleus from late normoblast, and it is the stage before mature red cells.
- Its percentage is a reflection of B.M. activity provided that it is corrected for anemia
- **Reticulocytosis** = ↑ reticulocyte count : hemolytic anemia , acute hemorrhage , acute hypoxia , anemia under treatment
- **Reticulocytopenia** = ↓ reticulocyte count : aplastic anemia & dyshemopoietic anemia

### LEUKOCYTES

- Total count : 4000 – 11,000 /mm<sup>3</sup>
- Differential count :

| Cell type                                                                                                                                                             | % (relative value) | Absolute value      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------|
| ➤ <b>Granular Leukocytes:</b>                                                                                                                                         |                    |                     |
| • Neutrophil (phagocytosis)                                                                                                                                           | 40 – 75 %          | 2,000 – 7,000 / cmm |
| • Eosinophil (histamine secretion)                                                                                                                                    | 1- 6 %             | 20 – 500 / cmm      |
| • Basophils (heparin secretion)                                                                                                                                       | < 2 %              | 20 – 100 / cmm      |
| ➤ <b>Non Granular Leukocytes</b>                                                                                                                                      |                    |                     |
| • Lymphocytes (immunity)                                                                                                                                              | 20 – 40 %          | 1,500 – 3,500 /cmm  |
| • Monocytes (phagocytosis)                                                                                                                                            | 2 – 10 %           | 200 – 1,000 /cmm    |
| • NB: All leucocytes (except lymphocytes) develop from bone marrow while lymphocytes develop from lymphoid tissue, therefor in any neutropenia there is lymphocytosis |                    |                     |

##### • **Neutrophils development** :

|                                                                                                                                                 |                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Staff (or stab) cells → segmented cells</li> <li>• Normal staff : segmented ratio : 1: 5-10</li> </ul> |                                                 |
| Abnormally :                                                                                                                                    |                                                 |
| Staff : segmented < 1:5<br>Shift to the left :                                                                                                  | Staff : segmented > 1: 10<br>Shift to the right |
| ↑ percentage of staff above normal ( 5 %) in overactive BM                                                                                      | ↑ segmentation in delayed BM                    |
| causes : in any leukocytosis                                                                                                                    | Cause : megaloblastic anemia                    |



## PLATELETS

- Normal count : 150,000 – 350,000 / mm<sup>3</sup>
- Function : hemostasis
- ↓ = Thrombocytopenia
- ↑ = Thrombocytosis

## ESR

1. **Definition** : distance sedimented by RBCS in a vertical blood column at the end of 1 or 2 hours.

2. **Mechanism** :

- Normally red cells are negatively charged and repel each other
- The increase in plasma globulin, fibrinogen causes decrease in these negative charges, allowing RBC to form rouleaux & increase their sedimentation.

3. **Normal value** : Westergren's method :

|        | 1 <sup>st</sup> hour | 2 <sup>nd</sup> hour |
|--------|----------------------|----------------------|
| Male   | 5 mm                 | 8 mm                 |
| female | 10 mm                | 16 mm                |

4. **Clinical significance** : prognostic value not diagnostic

5. **Causes of increase ESR** :

- Physiological : females during menses – pregnancy
- Pathological: TB – Malignancy – multiple myeloma - Rheumatic fever – collagen diseases.

6. **Causes of decreased ESR** : polycythemia , afibrinogenaemia , heart failure , sickle cell anemia

### ✓ Techniques :

❖ **Bleeding time** : normally 2- 7 min

#### • Technique :

- Cuff of sphygmomanometer inflated above venous ( > 40 mmHg)
- Puncture hand then repeatedly dry by paper and calculate by stop watch when bleeding stops “ Test for platelet + vascular ”

❖ **Clotting time** : normal 5 – 10 min :

#### • Technique

- Capillary tube filled with blood broken successively
- Calculate when thread formed

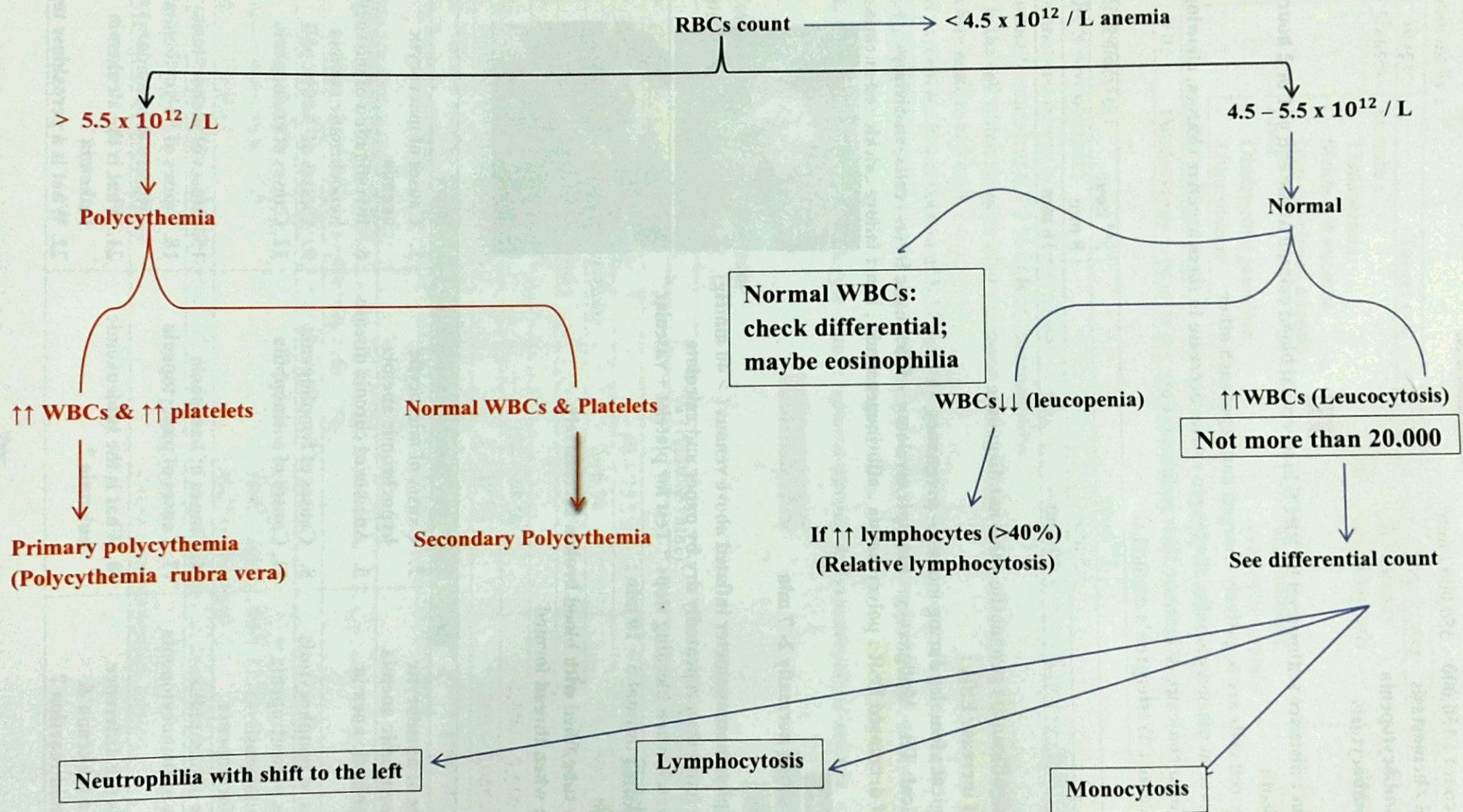


### ➤ Revise from your theoretical book the followings :

|                                                                    |                                            |                                                   |
|--------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------|
| 1. Causes of normocytic normochromic anemia                        | 2. Causes of microcytic hypochromic anemia | 3. Causes of macrocytic anemia                    |
| 4. Sideroblastic anemia                                            | 5. Anemia of chronic disease               | 6. Investigation of microcytic hypochromic anemia |
| 7. Causes of lymphocytosis                                         | 8. Causes of lymphopenia                   | 9. Causes of Neutrophil                           |
| 10. Causes of neutropenia = agranulocytosis = granulocytopenia     | 11. Causes of eosinophilia                 | 12. Causes of esoinopenia                         |
| 13. Causes of basophilia                                           | 14. Causes of basopenia                    | 15. Causes of monocytosis                         |
| 16. Causes of monocytopenia                                        | 17. Causes of pancytopenia                 | 18. Causes of Polycythemia ( Primary & secondary) |
| 19. What is the difference between leukemia & leukomoid reaction ? | 20. What is the subleukemic leukemia ?     | 21. What is the aleukemia leukemia ?              |
|                                                                    |                                            | 22. What is a peroxidase test ?                   |

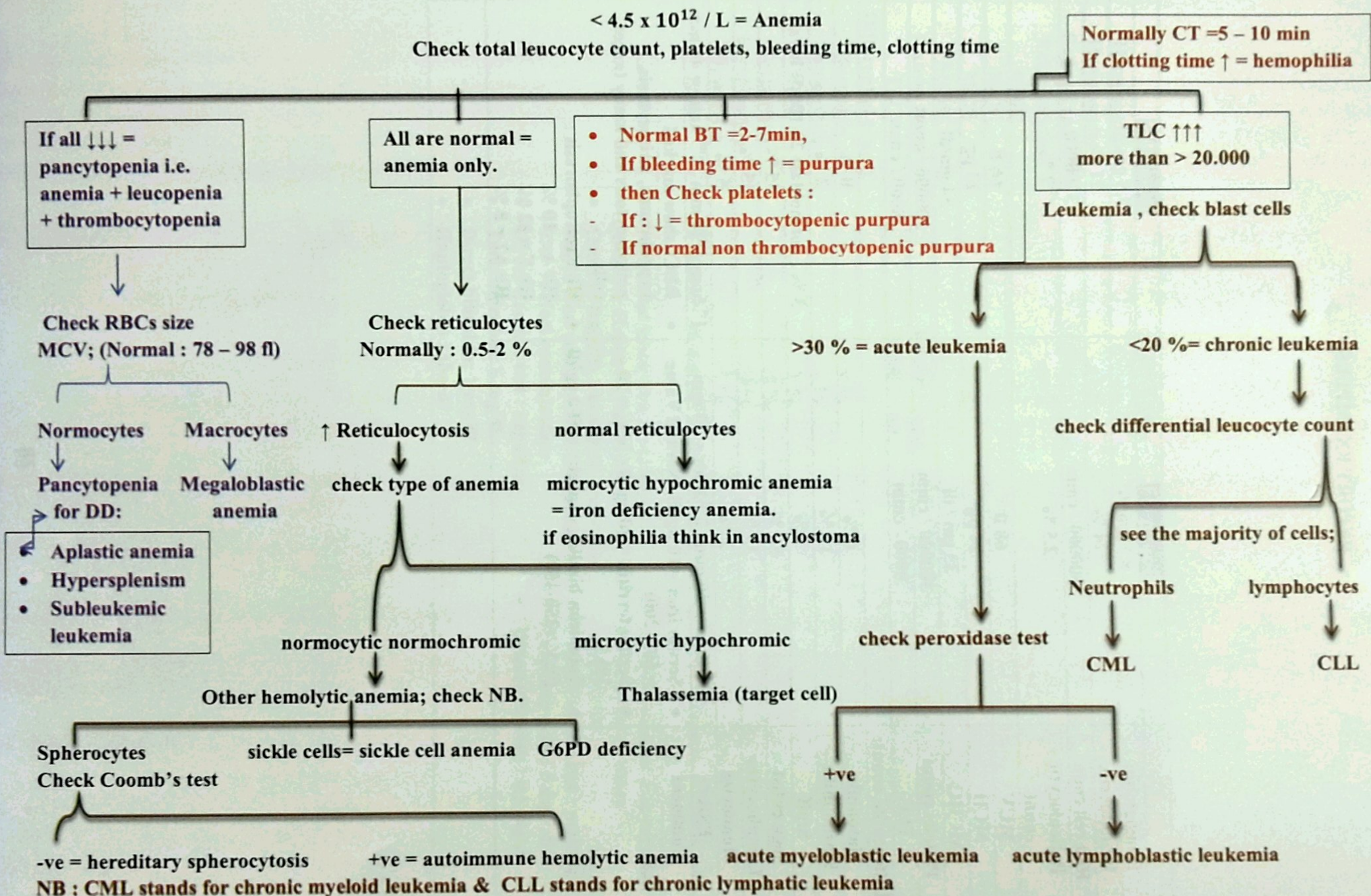


## DIAGNOSTIC PATHWAY FOR BLOOD REPORT



**NB:** In infectious mononucleosis, there are: lymphocytosis, monocytosis, atypical lymphocytes, +ve Monospot test, +ve Paul-Bunel test







## REPORT EXAMPLES

|                     | Example 1                                                                                                                                                                                                              | Example 2                                                                                                                                                                                                                                                                 |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hemoglobin          | 8.5 gm/dl                                                                                                                                                                                                              | 7.5 gm/dl                                                                                                                                                                                                                                                                 |
| Hematocrite         | 24 %                                                                                                                                                                                                                   | 21 %                                                                                                                                                                                                                                                                      |
| Red cell count      | 3500000 / cmm                                                                                                                                                                                                          | 3200000                                                                                                                                                                                                                                                                   |
| Reticulocytic count | 2.5 %                                                                                                                                                                                                                  | 7 %                                                                                                                                                                                                                                                                       |
| MCV                 | 68 fl                                                                                                                                                                                                                  | 66 fl                                                                                                                                                                                                                                                                     |
| MCH                 | 24 pg                                                                                                                                                                                                                  | 23 pg                                                                                                                                                                                                                                                                     |
| MCHC                | 33 gm / dl                                                                                                                                                                                                             | 34 gm/dl                                                                                                                                                                                                                                                                  |
| Platelet count      | 300000 / cmm                                                                                                                                                                                                           | 300000 / cmm                                                                                                                                                                                                                                                              |
| TLC                 | 8000 / cmm                                                                                                                                                                                                             | 8000 / cmm                                                                                                                                                                                                                                                                |
| Differential count: |                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                           |
| Basophils           | 0 %                                                                                                                                                                                                                    | 0 %                                                                                                                                                                                                                                                                       |
| Eosinophilis        | 12 %                                                                                                                                                                                                                   | 2 %                                                                                                                                                                                                                                                                       |
| Staff               | 3 %                                                                                                                                                                                                                    | 3 % , normoblast 20/100 WBCs                                                                                                                                                                                                                                              |
| Segmented           | 50 %                                                                                                                                                                                                                   | 55 %                                                                                                                                                                                                                                                                      |
| Lymphocytes         | 33 %                                                                                                                                                                                                                   | 35 %                                                                                                                                                                                                                                                                      |
| Monocytes           | 2 %                                                                                                                                                                                                                    | 5 %                                                                                                                                                                                                                                                                       |
| ESR                 | 1 <sup>st</sup> hour = 20 mm , 2 <sup>nd</sup> hour = 35 mm                                                                                                                                                            | 1 <sup>st</sup> hour = 20 mm , 2 <sup>nd</sup> hour = 40 mm                                                                                                                                                                                                               |
| Comment             | <ul style="list-style-type: none"> <li>Serum iron = 10 ug/dl (Normal Value = 50 – 200)</li> <li>Serum ferritin = 10 ug/dl ( N.V. = 20 - 30)</li> <li>Total iron binding capacity = 500 yg/dl (N.V.=250-450)</li> </ul> | <ul style="list-style-type: none"> <li>RBCs show marked hypochromia, anisocytosis, poikilocytosis and many target cells</li> <li>Hb electrophoresis : <ul style="list-style-type: none"> <li>Hb A = 10 %</li> <li>Hb F = 82 %</li> <li>Hb A2 = 8 %</li> </ul> </li> </ul> |



|                            | <b>Example 3</b>                                                                                                                                                                                                                                                                                                                                                              | <b>Example 4</b>                                                                                                                                                                                                                    |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Hemoglobin</b>          | <b>8.5 gm/dl</b>                                                                                                                                                                                                                                                                                                                                                              | <b>9 gm/dl</b>                                                                                                                                                                                                                      |
| <b>Hematocrite</b>         | <b>24 %</b>                                                                                                                                                                                                                                                                                                                                                                   | <b>27.5 %</b>                                                                                                                                                                                                                       |
| <b>Red cell count</b>      | <b>3100000 / cmm</b>                                                                                                                                                                                                                                                                                                                                                          | <b>3000000</b>                                                                                                                                                                                                                      |
| <b>Reticulocytic count</b> | <b>6 %</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>8 %</b>                                                                                                                                                                                                                          |
| <b>MCV</b>                 | <b>76 fl</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>91 fl</b>                                                                                                                                                                                                                        |
| <b>MCH</b>                 | <b>27 pg</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>30 pg</b>                                                                                                                                                                                                                        |
| <b>MCHC</b>                | <b>35 gm / dl</b>                                                                                                                                                                                                                                                                                                                                                             | <b>32 gm/dl</b>                                                                                                                                                                                                                     |
| <b>Platelet count</b>      | <b>400000 / cmm</b>                                                                                                                                                                                                                                                                                                                                                           | <b>350000 / cmm</b>                                                                                                                                                                                                                 |
| <b>TLC</b>                 | <b>10,000 / cmm</b>                                                                                                                                                                                                                                                                                                                                                           | <b>8000 / cmm</b>                                                                                                                                                                                                                   |
| <b>Differential count:</b> |                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                     |
| <b>Basophils</b>           | <b>0 %</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>0 %</b>                                                                                                                                                                                                                          |
| <b>Eosinophilis</b>        | <b>2 %</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>1 %</b>                                                                                                                                                                                                                          |
| <b>Staff</b>               | <b>3 %</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>4 %</b>                                                                                                                                                                                                                          |
| <b>Segmented</b>           | <b>60 %</b>                                                                                                                                                                                                                                                                                                                                                                   | <b>55 %</b>                                                                                                                                                                                                                         |
| <b>Lymphocytes</b>         | <b>30 %</b>                                                                                                                                                                                                                                                                                                                                                                   | <b>35 %</b>                                                                                                                                                                                                                         |
| <b>Monocytes</b>           | <b>5 %</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>5 %</b>                                                                                                                                                                                                                          |
| <b>ESR</b>                 | <b>1<sup>st</sup> hour = 20 mm , 2<sup>nd</sup> hour = 40 mm</b>                                                                                                                                                                                                                                                                                                              | <b>1<sup>st</sup> hour = 20 mm , 2<sup>nd</sup> hour = 45 mm</b>                                                                                                                                                                    |
| <b>Comment</b>             | <ul style="list-style-type: none"> <li>Peripheral blood film revealed the presence of many spherocytes</li> <li>Osmotic fragility : hemolysis started at 0.65% Nacl concentration and ended at 0.45 % Nacl concentration</li> <li>Direct Coombs test : negative</li> <li>Total bilirubin: 6 mg/dl</li> <li>Direct bilirubin: 1 mg/dl</li> <li>Haptoglobin : absent</li> </ul> | <ul style="list-style-type: none"> <li>Peripheral blood film revealed the presence of many spherocytes</li> <li>Direct Coombs test : positive</li> <li>Total bilirubin : 5 mg / dl</li> <li>Direct bilirubin : 0.1 mg/dl</li> </ul> |



|                            | <b>Example 5</b>                                                  | <b>Example 6</b>                                                                                        |
|----------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <b>Hemoglobin</b>          | <b>9 gm/dl</b>                                                    | <b>10 gm/dl</b>                                                                                         |
| <b>Hematocrite</b>         | <b>27.5 %</b>                                                     | <b>29 %</b>                                                                                             |
| <b>Red cell count</b>      | <b>3000000 / cmm</b>                                              | <b>3300000</b>                                                                                          |
| <b>Reticulocytic count</b> | <b>0.2 %</b>                                                      | <b>0.1 %</b>                                                                                            |
| <b>MCV</b>                 | <b>91 fl</b>                                                      | <b>87 fl</b>                                                                                            |
| <b>MCH</b>                 | <b>30 pg</b>                                                      | <b>30 pg</b>                                                                                            |
| <b>MCHC</b>                | <b>32 gm / dl</b>                                                 | <b>34 gm/dl</b>                                                                                         |
| <b>Platelet count</b>      | <b>20,000 / cmm</b>                                               | <b>500000 / cmm</b>                                                                                     |
| <b>TLC</b>                 | <b>70,000 / cmm</b>                                               | <b>200000 / cmm</b>                                                                                     |
| <b>Differential count:</b> |                                                                   |                                                                                                         |
| <b>Basophils</b>           | <b>0 %</b>                                                        | <b>5 %</b>                                                                                              |
| <b>Eosinophilis</b>        | <b>0 %</b>                                                        | <b>2 %</b>                                                                                              |
| <b>Staff</b>               | <b>1 %</b>                                                        | <b>10 %</b>                                                                                             |
| <b>Segmented</b>           | <b>5 %</b>                                                        | <b>32 %</b>                                                                                             |
| <b>Lymphocytes</b>         | <b>0 %</b>                                                        | <b>1 %</b>                                                                                              |
| <b>Monocytes</b>           | <b>1 %</b>                                                        | <b>2 %</b>                                                                                              |
|                            | <b>Blast 93 %</b><br><b>Peroxidase stain of blasts = negative</b> | <b>Blasts = 5 %</b><br><b>Promyelocytes = 3 %</b><br><b>Myelocytes = 25 %</b><br><b>Juvenile = 15 %</b> |
| <b>ESR</b>                 | <b>1<sup>st</sup> hour = 70 mm , 2<sup>nd</sup> hour = 130 mm</b> | <b>1<sup>st</sup> hour = 70 mm , 2<sup>nd</sup> hour = 120 mm</b>                                       |



|                     | <b>Example 7</b>                                            |
|---------------------|-------------------------------------------------------------|
| Hemoglobin          | 11.5 gm/dl                                                  |
| Hematocrite         | 35 %                                                        |
| Red cell count      | 3800000 / cmm                                               |
| Reticulocytic count | 2 %                                                         |
| MCV                 | 92 fl                                                       |
| MCH                 | 30 pg                                                       |
| MCHC                | 33 gm / dl                                                  |
| Platelet count      | 250000 / cmm                                                |
| TLC                 | 350000 / cmm                                                |
| Differential count: |                                                             |
| Basophils           | 0 %                                                         |
| Eosinophils         | 1 %                                                         |
| Staff               | 2 %                                                         |
| Segmented           | 15 %                                                        |
| Lymphocytes         | 80 %                                                        |
| Monocytes           | 2 %                                                         |
| ESR                 | 1 <sup>st</sup> hour = 50 mm , 2 <sup>nd</sup> hour = 80 mm |

| Example Number | Answer                                                  |
|----------------|---------------------------------------------------------|
| Example 1      | Iron deficiency anemia with eosinophilia ( ankylostoma) |
| Example 2      | Hemolytic anemia ( thalassemia major)                   |
| Example 3      | Hemolytic anemia (hereditary spherocytosis)             |
| Example 4      | Hemolytic anemia ( autoimmune hemolytic anemia)         |
| Example 5      | Acute leukemia (lymphoblastic)                          |
| Example 6      | Chronic myeloid leukemia                                |
| Example 7      | Chronic lymphatic leukemia                              |

➤ The MCQs on CD are very very very important for the MCQs Exam ...!



| <b>The CD contains MCQs questions for the clinical pathology : HEMATOLOGY MCQS</b> |                       |                     |
|------------------------------------------------------------------------------------|-----------------------|---------------------|
| Red blood cells                                                                    | From question no. 1   | To question no. 17  |
| Anemia                                                                             | From question no. 18  | To question no. 59  |
| Polycythemia                                                                       | From question no. 60  | To question no. 61  |
| ESR                                                                                | From question no. 62  | To question no. 70  |
| Leucocytes                                                                         | From question no. 71  | To question no. 107 |
| Leukemia                                                                           | From question no. 108 | To question no. 161 |
| Hemostasis                                                                         | From question no. 162 | To question no. 187 |
| Blood transfusion                                                                  | From question no. 188 | To question no. 196 |



## ➤ URINE ANALYSIS :

| Normal value :                          |                                         |                                |
|-----------------------------------------|-----------------------------------------|--------------------------------|
| ➤ Physical properties                   | ➤ Chemical constituents                 | ➤ Microscopic                  |
| • Volume /day : 1-1 ½ liters            | • Glucose : nil                         | • Epithelial cells : few       |
| • Specific gravity :<br>1015 – 1025     | • Acetone : nil                         | • RBCs: 0-5 /HPF               |
| • Aspect : clear                        | • Proteins : nil or +                   | • WBCs (pus cells): 0-5/HPF    |
| • Color : amber yellow                  | • Bilirubin (bile pigment): nil         | • Ova (parasites) : nil        |
| • Reaction (pH) : acidic :<br>5.5 – 6.5 | • Urobilinogen : nil or normal<br>trace | • Crystals : nil or +          |
|                                         |                                         | • Casts : nil or hyaline casts |

## Clinical points for discussion

### ➤ Casts :

- Definition : coagulated Tamm-Horsfall protein cast formed in tubular lumen , normally = 150 mg / day
- Significance : upper urinary tract pathology
- Causes of casturia :

| 1. Acellular casts                                                              | 2. Cellular cast                                              |
|---------------------------------------------------------------------------------|---------------------------------------------------------------|
| A. Hyaline : ± normal<br>Commonest form and found in nearly all kidney diseases | A. Epithelial cast : in acute G.N. and acute tubular necrosis |
| B. Fatty (lipoid) : in nephrotic syndrome                                       | B. Granular casts : diabetic nephropathy & amyloidosis        |
|                                                                                 | C. broad cast : in chronic renal failure (chronic G.N.)       |
|                                                                                 | D. Red cell casts : acute G.N.                                |
|                                                                                 | E. White cell casts : in pyelonephritis                       |

### ➤ Crystals :

#### 1. Acidic urine :

- Ca oxalate crystals : envelop shape with hyperoxaluria
- Uric acid crystals : rhomboid shape with hyperuricosuria and acute urate nephropathy

#### 2. Alkaline urine : triple phosphate crystals (coffin lid shape)

#### 3. Cysteine crystals : in cystinuria

#### 4. Sulfur crystals : with sulfadiazine antibiotic

### ➤ Causes of red urine :

#### 1. Hematuria e.g. renal carcinoma , tuberculosis and bilharziasis

#### 2. Hemoglobinuria e.g. thalassemia & G6PD deficiency

#### 3. Myoglobinuria : crush syndrome

#### 4. Other causes of dark urine :

- Diet : beet root
- Drugs : rifampicin – phenytoin – Adriamycin
- Diseases : obstructive jaundice – viral hepatitis
- Dies : phenolphthalein



### ➤ Causes of white urine :

#### 1. Uricosuria

2. **Phosphaturia** : clears up on addition of acetic acid

3. **Pyuria** : more than 5 WBCs – HPF

#### ➤ Causes :

- Urinary tract infection
  - Acute GN
  - Sterile pyuria : TB nephritis , antibiotic therapy , non bacterial pyouria
4. **Chyluria** : presence of fat in urine in filariasis , fat clears by addition of ether

### ➤ Proteinuria :

- Definition : urine protein / 24 hr > 150 mg , nephrotic proteinuria > 3.5 gm / day
- Causes : revise them from your theoretical book

### ➤ Polyuria :

- Definition : volume of urine more than 1.5 liter / day
- Causes : revise them from your theoretical book

### ➤ Oliguria :

- Definition : volume of urine less than 400 CC / day
- Causes : revise them from your theoretical book

### ➤ Anuria

- Definition : complete absence of urine output for more than 12 – 24 hours
- Causes : revise them from your theoretical book

## ✓ Techniques

### ❖ Testing urine for glucose :

A. **Old methods** : Fehling's & Benedict's tests

- Idea : glucose is a reducing agent



- Reagent (colour)  $\xrightarrow[\text{(glucose)}]{\text{reducing substance}}$  reduced reagent (another colour)

- Disadvantage : non specific
  - False +ve :
    - CHO other than glucose ( e.g. lactose so +ve in lactating females)
    - Non-CHO : Asprin , Ascorbic acid
- B. **Recent methods** : strips has enzymes glucose oxidase
- Only react with glucose → change colour of strip ; highly specific

### ❖ Testing urine for proteins :

A. **Old methods** : by heating test → coagulation → either proteins or phosphate

- To DD add acetic acid ; if dissolve , so it's phosphate & if not so it 's proteins

B. **Recent methods** : by strips which is sensitive to albumin in urine

- Normal albumin trace in urine is 10 mg % (150 mg/day)
- If > 10 mg% → proteinuria → change the colour of strip





## DIAGNOSTIC PATHWAY FOR URINE REPROT

Check specific gravity (SG)

**Very low SG;  
< 1010 = polyuria,  
Either**

- Diabetes insipidus or
- Functional DD by water deprivation test

**Low fixed SG;  
1010 = Renal Failure  
Either**

- Pus cells ↑ → chronic PN or
- Proteins ↑ → No Syndrome

| Check            | Normal SG; 1015 - 1025                                                                                                                                                                                                                          | High SG; > 1025                                                                                                      |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| 1. Aspect turbid | Either :<br>• Aspect turbid + Pus cells ↑ (↑WBCs= white casts = pyuria ) → acute PN ( pyelonephritis)<br>OR<br>• Aspect turbid + Pus cells ↑ ( WBCs) + RBCs ↑ + crystals → Crystaluria<br>- Check type of crystals : oxalate , urate , ... etc. |                                                                                                                      |
| 2. Proteins ↑↑↑  | Nephrotic (No) syndrome (± fatty cast = lipoid cast)                                                                                                                                                                                            |                                                                                                                      |
| 3.               | • Color red + RBCs ↑↑↑<br>→ hematuria for DD<br>- Check ova for bilharziasis                                                                                                                                                                    | • Aspect smoky + Red cell cast + RBCs ↑↑↑ → acute GN                                                                 |
| 4.               | • Bilirubin only → obstructive jaundice<br>• Urobilinogen only → hemolytic jaundice<br>• Both → hepatocellular jaundice                                                                                                                         | • Glucose ± acetone → DM<br>If there are proteins↑↑↑→ think in diabetic nephropathy i.e. Kimmelstiel Wilson syndrome |
| 5.               | All rest of report normal → diminished water intake                                                                                                                                                                                             |                                                                                                                      |

NB : PN stands for pyelonephritis , No stands for Nephrotic .



## REPORT EXAMPLES

| Example 1               |                        |
|-------------------------|------------------------|
| Physical examination    |                        |
| Volume                  | 200 cc (random sample) |
| Colour                  | Amber yellow           |
| Reaction                | Acidic                 |
| Specific gravity        | 1025                   |
| Aspect                  | turbid                 |
| Chemical examination    |                        |
| Albumin                 | ++                     |
| Sugar                   | Nil                    |
| Acetone                 | Nil                    |
| Bile pigments           | Nil                    |
| Uroblinogen             | Norma trace            |
| Microscopic examination |                        |
| Epithelial cells        | ++                     |
| Pus cells               | > 100 / HPF            |
| RBCs                    | 2-3 / HPF              |
| Crystals                | Nil                    |
| Casts                   | Nil                    |
| Diagnosis               |                        |

| Example 2               |                | Example 3                                        |
|-------------------------|----------------|--------------------------------------------------|
| Physical examination    |                |                                                  |
| Volume                  | 4000 cc/24 hrs | 100 cc (random sample)                           |
| Colour                  | Pale yellow    | Amber yellow                                     |
| Reaction                | Acidic         | Alkaline                                         |
| Specific gravity        | 1002           | 1030                                             |
| Aspect                  | clear          | turbid                                           |
| Chemical examination    |                |                                                  |
| Albumin                 | Nil            | +                                                |
| Sugar                   | Nil            | ++                                               |
| Acetone                 | Nil            | Nil                                              |
| Bile pigments           | Nil            | Nil                                              |
| Uroblinogen             | Norma trace    | Norma trace                                      |
| Microscopic examination |                |                                                  |
| Epithelial cells        | Nil            | +                                                |
| Pus cells               | 0-1 / HPF      | 15 – 20 / HPF                                    |
| RBCs                    | 0-1 / HPF      | 8-10 / HPF                                       |
| Crystals                | Nil            | Amorphous phosphate (+)<br>Triple phosphate (++) |
| Casts                   | Nil            | Nil                                              |
| Ova                     | Nil            | Nil                                              |
| Diagnosis               |                |                                                  |

| Example number | Answer                |
|----------------|-----------------------|
| 1              | Acute pyelonephritis  |
| 2              | Polyuria (D.I.)       |
| 3              | Crystalluria ( +D.M.) |



## KIDNEY FUNCTION TESTS

| Diagnostic pathway in kidney profile                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Abnormality :                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                           |
| <p>➤ <b>Non protein nitrogenous compounds = NPN = normal kidney function :</b></p> <ul style="list-style-type: none"> <li>- Blood urea : 15 – 40 mg%</li> <li>• BUN = blood urea nitrogen = urea divided by 2.14</li> <li>- Serum uric acid : 2- 7 mg %</li> </ul>                                                                                                                                   | Increase in renal failure (acute & chronic)                                                                                               |
| <p>➤ <b>Electrolytes :</b></p> <ul style="list-style-type: none"> <li>- Serum K : 3.5 – 5 mg%</li> <li>- Serum phosphate : 2.5 – 5.5 mg%</li> </ul>                                                                                                                                                                                                                                                  |                                                                                                                                           |
| <ul style="list-style-type: none"> <li>- Blood sugar :<br/>Fasting : 70 – 110 mg%<br/>2 hrs post prandial : &lt; 140 mg%</li> </ul>                                                                                                                                                                                                                                                                  |                                                                                                                                           |
| <ul style="list-style-type: none"> <li>- Serum creatinine : 0.6 – 1.4 mg %</li> <li>• It is the end product of creatine coming from muscles.</li> <li>• It's level in blood inversely related to GFR</li> </ul>                                                                                                                                                                                      |                                                                                                                                           |
| <ul style="list-style-type: none"> <li>• <b>NB : Creatinine clearance :</b></li> <li>- Definition : volume of blood (in ml) cleared from its creatinine content per minute</li> <li>- Normal Value : 125 ml /min = glomerular filtration rate; GFR</li> <li>- Decrease in renal failure (acute &amp; chronic)</li> <li>- Better than serum creatinine as it's parallel to kidney function</li> </ul> |                                                                                                                                           |
| <ul style="list-style-type: none"> <li>- Calculated from : <math>\frac{\text{urine creatinine} \times \text{urine volume}}{\text{plasma creatinine}} = \frac{U \times V}{P}</math></li> </ul>                                                                                                                                                                                                        |                                                                                                                                           |
| <ul style="list-style-type: none"> <li>- Serum Na : 135 – 145 mEq%</li> </ul>                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>• Decrease in acute renal failure</li> <li>• Variable in chronic renal failure (↑ or ↓)</li> </ul> |
| <ul style="list-style-type: none"> <li>- Serum Ca : 9 – 11 mg %</li> </ul>                                                                                                                                                                                                                                                                                                                           | Decrease in chronic renal failure only                                                                                                    |
| <ul style="list-style-type: none"> <li>- Serum albumin : 4 – 6 gm %</li> </ul>                                                                                                                                                                                                                                                                                                                       | Decrease in nephrotic syndrome                                                                                                            |
| <ul style="list-style-type: none"> <li>- Serum Cholesterol : 150 - 200 mg %</li> </ul>                                                                                                                                                                                                                                                                                                               | Increase in nephrotic syndrome                                                                                                            |

### ➤ Possibilities include :

1. Nephrotic syndrome with normal kidney function
  2. Renal failure without nephrotic syndrome
  3. Renal failure with nephrotic syndrome
  4. Renal failure with renal osteodystrophy
- ↑ alkaline phosphatase
  - Serum bilirubin normal to exclude liver diseases

### ✓ Which is better ?

#### ❖ Blood urea or serum creatinine ? serum creatinine

- Blood urea is affected by many factors : dietary protein , tissue catabolism , liver functions & kidney functions
- While serum creatinine is affected by kidney functions and muscle mass which is fixed

#### ❖ Serum creatinine or urea clearance ? urea clearance

- Both are good monitors of kidney functions but urea clearance is better as it determine percentage of functioning tissue of the kidney

#### ❖ Urea clearance or creatinine clearance ? creatinine clearance

- Creatinine clearance is better as it is dependent on GFR which is fixed , while urea clearance is changed by change of urine volume



## REPORT EXAMPLES

| Example 1        |            |                     |
|------------------|------------|---------------------|
| Serum urea       | 250 mg /dl | Normal : 10 – 50    |
| Serum creatinine | 10.5 mg/dl | Normal : 0.4 – 1.4  |
| Serum uric acid  | 9 mg/dl    | Normal : 3.2 – 7    |
| Serum phosphorus | 7 mg/dl    | Normal : 2.5 – 5    |
| Serum calcium    | 7.1 mg/dl  | Normal : 8.5 – 10.5 |
| Serum Na         | 128 mmol/L | Normal : 135 – 145  |
| Serum K          | 6 mmol/L   | Normal : 3.5 – 5.2  |
| Blood sugar      | 200 mg/dl  |                     |
| Diagnosis        |            |                     |

| Example 2           |            |                    |
|---------------------|------------|--------------------|
| Serum urea          | 140 mg /dl | Normal : 10 – 50   |
| Serum creatinine    | 3.1 mg/dl  | Normal : 0.4 – 1.4 |
| Serum cholesterol   | 350 mg/dl  | Normal : 50 – 250  |
| Serum total protein | 6 g/dl     | Normal : 6.6 – 8.6 |
| Serum albumin       | 2.3 g/dl   | Normal : 3.5 – 5.5 |
| Serum Na            | 139 mmol/L | Normal : 135 – 145 |
| Serum K             | 5.8 mmol/L | Normal : 3.5 – 5.2 |
| Diagnosis           |            |                    |

| Example 3           |            |                    |
|---------------------|------------|--------------------|
| Serum urea          | 50 mg /dl  | Normal : 10 – 50   |
| Serum creatinine    | 1.2 mg/dl  | Normal : 0.4 – 1.4 |
| Serum cholesterol   | 350 mg/dl  | Normal : 50 – 250  |
| Serum total protein | 6 g/dl     | Normal : 6.6 – 8.6 |
| Serum albumin       | 2.3 g/dl   | Normal : 3.5 – 5.5 |
| Serum Na            | 139 mmol/L | Normal : 135 – 145 |
| Serum K             | 5 mmol/L   | Normal : 3.5 – 5.2 |
| Diagnosis           |            |                    |

| Example number | Answer                      |
|----------------|-----------------------------|
| 1              | Chronic renal failure       |
| 2              | Nephrotic syndrome with CRF |
| 3              | Nephrotic syndrome          |



## ACID - BASE BALANCE

➤ Comment on the following :

➤ State of acid base balance , normal values :

- pH = 7.35 – 7.45
- ↑ = alkaline , ↓ = acidic
- Serum bicarbonate ( $\text{HCO}_3$ ) : 21 – 28 mmol/L
- Blood  $\text{CO}_2$  : 35 – 45 mmHG

### Diagnostic pathway

#### Look at PH value

Decreased = Acidosis

Increased = alkalosis

Look at bicarbonate ( $\text{HCO}_3$ ) and  $\text{CO}_2$  level

Low  $\text{HCO}_3$  only =  
uncompensated  
metabolic acidosis

Low  $\text{HCO}_3$  &  
low  $\text{Pco}_2$  =  
compensated  
metabolic acidosis

High  $\text{HCO}_3$  only =  
uncompensated  
metabolic alkalosis

High  $\text{HCO}_3$  &  
high  $\text{Pco}_2$  =  
compensated  
metabolic alkalosis

High  $\text{Pco}_2$  only =  
uncompensated  
respiratory acidosis

High  $\text{Pco}_2$  &  
high  $\text{HCO}_3$   
compensated  
respiratory acidosis

Low  $\text{Pco}_2$  only =  
uncompensated  
respiratory alkalosis

Low  $\text{Pco}_2$  &  
low  $\text{HCO}_3$  =  
compensated  
respiratory alkalosis

Mixed metabolic and  
respiratory acidosis =

- Marked decrease of pH
- Near normal  $\text{Pco}_2$
- Near normal  $\text{HCO}_3$



## REPORT EXAMPLES

| Example   | 1        | 2    | 3    | 4    | 5    | 6    | 7    | 8   |
|-----------|----------|------|------|------|------|------|------|-----|
| Pco2      | 23 mmHg  | 27   | 20   | 65   | 60   | 68   | 24   | 42  |
| pH        | 7.21     | 7.22 | 7.20 | 7.21 | 7.22 | 7.19 | 7.52 | 7.1 |
| HC03      | 11 mEq/L | 12   | 12   | 29   | 30   | 27   | 20   | 20  |
| Diagnosis |          |      |      |      |      |      |      |     |

| Example | Answer                                   |
|---------|------------------------------------------|
| 1       | Compensated Metabolic acidosis           |
| 2       | Compensated Metabolic acidosis           |
| 3       | Compensated Metabolic acidosis           |
| 4       | Compensated Respiratory acidosis         |
| 5       | Compensated Respiratory acidosis         |
| 6       | Uncompensated Respiratory acidosis       |
| 7       | Compensated Respiratory alkalosis        |
| 8       | Mixed metabolic and respiratory acidosis |

➤ Revise from your theoretical book the following :

- Causes of acidosis ( respiratory & metabolic)
- Causes of alkalosis ( respiratory & metabolic)



| The CD contains MCQs questions for the clinical pathology : NEPHROLOGY MCQS |                       |                     |
|-----------------------------------------------------------------------------|-----------------------|---------------------|
| Renal diseases                                                              | From question no. 197 | To question no. 222 |
| Calcium & phosphorus                                                        | From question no. 223 | To question no. 230 |
| Sodium & potassium                                                          | From question no. 231 | To question no. 235 |
| Acid – base balance                                                         | From question no. 236 | To question no. 240 |



## LIVER FUNCTION TESTS

Normal :

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------------|---------------------|-----------------------|------|-----------------|-----------------|---------|-------------------------------|---|----------|---|---|------------|--------|-----------------------------|
| Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Normal value                                                |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <b>Protein metabolism</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 1- Total protein                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 7 – 9 gm %                                                  |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 2- Albumin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 4 – 5 gm %                                                  |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 3- Globulin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2 – 3 gm %                                                  |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 4- A/G ratio                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2:1                                                         |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>Abnormality : <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td></td><td>Acute liver disease</td><td>Chronic liver disease</td></tr> <tr> <td>e.g.</td><td>Viral hepatitis</td><td>Liver cirrhosis</td></tr> <tr> <td>Albumin</td><td>Not affected (Long life span)</td><td>↓</td></tr> <tr> <td>Globulin</td><td>↑</td><td>↑</td></tr> <tr> <td>A/G ration</td><td>Normal</td><td>Decreased or even reversed.</td></tr> </table> </li> </ul> |                                                             |                             | Acute liver disease | Chronic liver disease | e.g. | Viral hepatitis | Liver cirrhosis | Albumin | Not affected (Long life span) | ↓ | Globulin | ↑ | ↑ | A/G ration | Normal | Decreased or even reversed. |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Acute liver disease                                         | Chronic liver disease       |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| e.g.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Viral hepatitis                                             | Liver cirrhosis             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| Albumin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Not affected (Long life span)                               | ↓                           |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| Globulin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ↑                                                           | ↑                           |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| A/G ration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Normal                                                      | Decreased or even reversed. |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <b>Fat metabolism</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 1- Serum cholesterol                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 150 – 200 mg %                                              |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 2- Phospholipids                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 150 – 250 mg %                                              |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <b>Carbohydrate metabolism</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 1- Glucose tolerance test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | See detail later                                            |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 2- Lag storage curve is seen in liver cirrhosis, where there is rapid rise of blood glucose, peak is higher than normal, but the curve return to normal in less than 2 hours                                                                                                                                                                                                                                                                                                                                                       |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <b>Bile pigments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 1- Total bilirubin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0.2 – 1 mg%                                                 |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>It increases in all types of jaundice.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 2- Direct (cholebilirubin - conjugated)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0.2 mg %                                                    |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>Increase mainly in obstructive jaundice</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 3- Indirect (hemobilirubin – unconjugated)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0.8 mg%                                                     |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>Increase mainly in hemolytic jaundice</li> <li>Both direct and indirect increase in hepatocellular jaundice</li> </ul>                                                                                                                                                                                                                                                                                                                                                                      |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <b>Bile salts:</b> normally absent from urine. They present in obstructive jaundice                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <b>Biliary patency enzymes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 1- Serum alkaline phosphatase (ALP) :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3 – 13 K.A. units (King-Armstrong unit)<br>Or 30 – 130 IU/L |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>It increase in both liver and bone disease</li> <li>In hepatocellular jaundice : it is between 3 - 30 K.A. units</li> <li>If it is &gt; 30 units it is either obstructive jaundice or space occupying lesion in liver</li> <li>➤ How to confirm that increased ALP is due to liver disease &amp; not bone disease :</li> <li>- Associated increase in GGT</li> <li>- Associated increased in 5- nucleotidase</li> <li>- Abdominal ultrasonography</li> </ul>                                |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 2- Serum 5-nucleotidase :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1.5 IU/L                                                    |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>It increases in obstructive jaundice</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| 3- Gamma glutamyl transpeptidase (GGT) :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 30 IU/l                                                     |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |
| <ul style="list-style-type: none"> <li>It increases in both obstructive jaundice &amp; hepatocellular jaundice (the most sensitive)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                     |                                                             |                             |                     |                       |      |                 |                 |         |                               |   |          |   |   |            |        |                             |

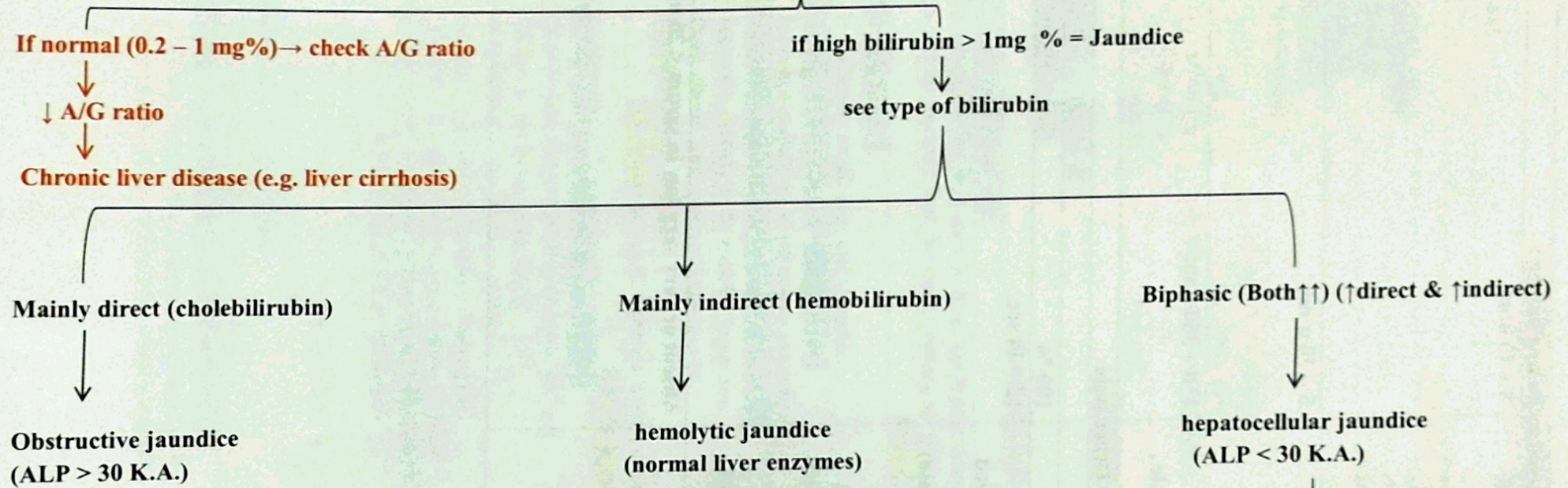


| Test for hepatocellular damage :                                                                                                                                                                                                                                                                                                                                                                                                                                |                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| <b>1- Serum glutamic oxaloacetic transaminase (SGOT) = Aspartate transaminase (AST) :</b> <ul style="list-style-type: none"> <li>It is non-specific , increase in liver diseases especially chronic forms , heart , kidney, muscles diseases e.g. active liver damage, acute myocardial infarction , acute kidney affection , severe cases of myopathy.</li> </ul>                                                                                              | 8 – 40 u/ml                                 |
| <b>2- Serum glutamic pyruvic transaminase (SGPT) = Alanine transaminase (ALT) :</b> <ul style="list-style-type: none"> <li>It is specific for liver diseases especially acute forms e.g. viral hepatitis</li> </ul>                                                                                                                                                                                                                                             | 5 – 30 u/ml                                 |
| <b>3- Lactic dehydrogenase (LDH) :</b> <ul style="list-style-type: none"> <li>Non-specific : it increases in liver , muscle , cardiac and renal diseases.</li> </ul>                                                                                                                                                                                                                                                                                            | 150 – 360 u/ml                              |
| Other tests                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                             |
| <b>1- Prothrombin :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                             |
| <b>Prothrombin concentration</b>                                                                                                                                                                                                                                                                                                                                                                                                                                | 100 %                                       |
| <b>Prothrombin time (PT):</b> <ul style="list-style-type: none"> <li>Best expressed as international normalized ratio “INR”</li> <li>PT is prolonged (&amp; concentration decrease) in both hepatocellular &amp; obstructive jaundice</li> <li>They are differentiated by vitamin K IM which improves PT in obstructive jaundice only.</li> <li>PT is prolonged also in : mal-absorption , oral-anticoagulant use &amp; prolonged use of antibiotics</li> </ul> | 12 – 14 sec                                 |
| <b>2- Alpha-feto protein :</b> <ul style="list-style-type: none"> <li>Moderate elevation ( 20 – 500 ng/ml) : in               <ul style="list-style-type: none"> <li>Hepatitis &amp; cirrhosis</li> <li>Pancreatitis</li> <li>Malignancy : GIT, ovary , testis</li> </ul> </li> <li>Marked elevation ( &gt; 500 ng/ml)               <ul style="list-style-type: none"> <li>Hepatocellular carcinoma</li> </ul> </li> </ul>                                     | Absent or very very low in serum < 20 ng/ml |



# **Diagnostic pathway for liver :**

## **See bilirubin :**



| Check     | Acute liver disease | Chronic liver disease |
|-----------|---------------------|-----------------------|
| Albumin   | Normal              | ↓                     |
| A/G ratio | Normal (2:1)        | ↓ (1:2) or reversed   |
| PC        | Normal              | ↓                     |
| e.g.      | Viral hepatitis     | Liver cirrhosis       |



## Report Examples of liver profiles

**Example 1**

|                              |                                |
|------------------------------|--------------------------------|
| Total bilirubin              | 3.2 mg/dl ( Normal 0.1 – 1 )   |
| Direct bilirubin             | 1.2 mg/dl ( Normal : 0 - 0.25) |
| AST                          | 1250 U/L ( Normal : 0 - 32)    |
| ALT                          | 1550 U/L (Normal : 0 - 31)     |
| Alkaline phosphatase protein | 390 U/L (Normal : 79 : 240)    |
| Total protein                | 7 g/dl ( Normal : 6.6 8.6)     |
| Albumin                      | 3.8 g/dl (Normal 3.5 – 5.5)    |
| Diagnosis                    |                                |

**Example 2**

|                              |                                |
|------------------------------|--------------------------------|
| Total bilirubin              | 5.1 mg/dl ( Normal 0.1 – 1 )   |
| Direct bilirubin             | 0.3 mg/dl ( Normal : 0 - 0.25) |
| AST                          | 25 U/L ( Normal : 0 - 32)      |
| ALT                          | 18 U/L (Normal : 0 - 31)       |
| Alkaline phosphatase protein | 211 U/L (Normal : 79 : 240)    |
| Total protein                | 7.5 g/dl ( Normal : 6.6 8.6)   |
| Albumin                      | 5 g/dl (Normal 3.5 – 5.5)      |
| Diagnosis                    |                                |

**Example 3**

|                              |                                 |
|------------------------------|---------------------------------|
| Total bilirubin              | 0.88 mg/dl ( Normal 0.1 – 1 )   |
| Direct bilirubin             | 0.35 mg/dl ( Normal : 0 - 0.25) |
| AST                          | 95 U/L ( Normal : 0 - 32)       |
| ALT                          | 57 U/L (Normal : 0 - 31)        |
| Alkaline phosphatase protein | 287 U/L (Normal : 79 : 240)     |
| Total protein                | 7.4 g/dl ( Normal : 6.6 8.6)    |
| Albumin                      | 2.9 g/dl (Normal 3.5 – 5.5)     |
| A/G ratio                    | 0.6 ( Normal : 1.1 – 2.5)       |
| Diagnosis                    |                                 |

**Example 4**

|                              |                                 |
|------------------------------|---------------------------------|
| Total bilirubin              | 17.1 mg/dl ( Normal 0.1 – 1 )   |
| Direct bilirubin             | 15.6 mg/dl ( Normal : 0 - 0.25) |
| AST                          | 70 U/L ( Normal : 0 - 32)       |
| ALT                          | 100 U/L (Normal : 0 - 31)       |
| Alkaline phosphatase protein | 1200 U/L (Normal : 79 : 240)    |
| Albumin                      | 3.5 g/dl (Normal 3.5 – 5.5)     |
| Diagnosis                    |                                 |

| Example number | Answer                        |
|----------------|-------------------------------|
| 1              | Acute hepatocellular jaundice |
| 2              | Hemolytic jaundice            |
| 3              | Liver cirrhosis               |
| 4              | Obstructive jaundice          |



## Serology of viral hepatitis

### Hepatitis A,D,E markers

| Hepatitis   | Acute stage    | Chronic stage  |
|-------------|----------------|----------------|
| Hepatitis A | Anti -HAV- IgM | Anti -HAV- IgG |
| Hepatitis D | Anti -HDV- IgM | Anti -HDV- IgG |
| Hepatitis E | Anti -HEV- IgM | Anti -HEV- IgG |

### Hepatitis C markers

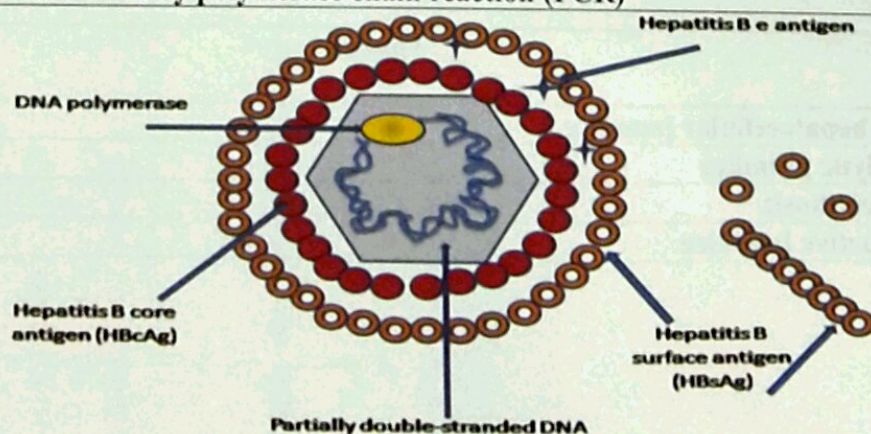
| Marker          | Technique                                                                                                                 | Time                            | Significance                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------------------|
| HCV -Ab         | <ul style="list-style-type: none"> <li>3<sup>rd</sup> generation ELISA and confirmed by RIBA</li> </ul>                   | After 3 – 6 months of infection | Exposure to infection , not immunity |
| HCV – Viral RNA | PCR <ul style="list-style-type: none"> <li>Recently quantitative PCR to monitor effect of interferon treatment</li> </ul> | After 1 – 2 weeks               | Indicate active virus                |

- NB :

- ELISA = Enzyme-linked immunosorbent assay
- RIBA = recombinant immunoblot assay

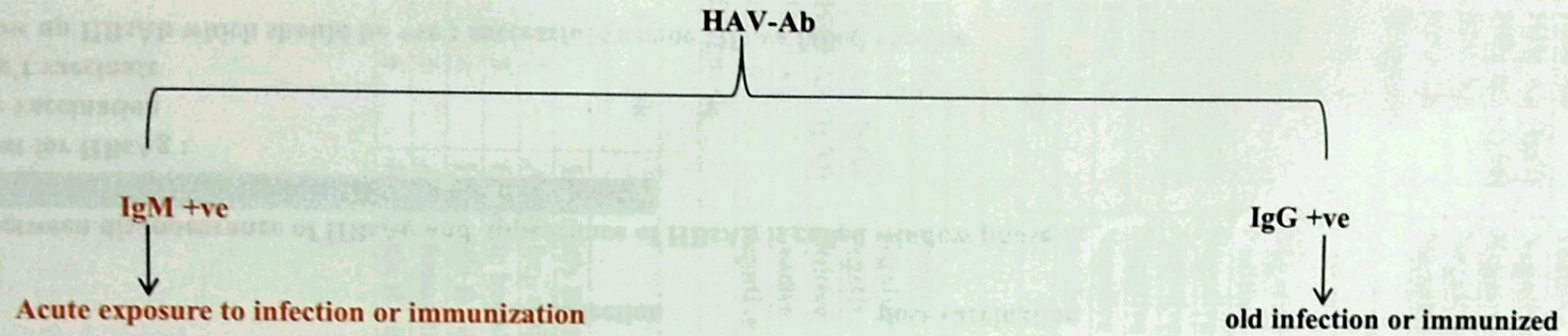
### Hepatitis B markers

| Antigen               | Significance                                                                                                                                                                                | Antibody         | Significance                                                                                                                                                                                                                                               |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HBsAg (surface)       | <ul style="list-style-type: none"> <li>Appear after 6 week</li> <li>Acute infection if remains for 3 months</li> <li>Chronic infection or carrier if more than 6 months</li> </ul>          | HBsAb = Anti-HBs | <ul style="list-style-type: none"> <li>Appear after 3 months</li> <li>Reflect :               <ul style="list-style-type: none"> <li>- Past infection &amp; natural immunity (if with HBcAb)</li> <li>- Post vaccination (if alone)</li> </ul> </li> </ul> |
| HBcAg (core)          | Detected only in liver biopsy(not in serum)                                                                                                                                                 | HBcAb= Anti-HBc  | <ul style="list-style-type: none"> <li>Appear after 2 months</li> <li>Reflect :               <ul style="list-style-type: none"> <li>- HBcAbIgM : recent infection</li> <li>- HBcAbIgG : recovery (past infection) (if with HBsAb)</li> </ul> </li> </ul>  |
| HBeAg (envelop)       | Reflect viral replication (chronicity; high infectivity )                                                                                                                                   | HBeAb = Anti-HBe | <ul style="list-style-type: none"> <li>Appear after 2.5 months</li> <li>Reflect non replicating virus; good prognosis</li> </ul>                                                                                                                           |
| Hepatitis B viral DNA | <ul style="list-style-type: none"> <li>• Most sensitive index for viral replication &amp; chronicity called Dane particle</li> <li>• Detected by polymerase chain reaction (PCR)</li> </ul> |                  |                                                                                                                                                                                                                                                            |

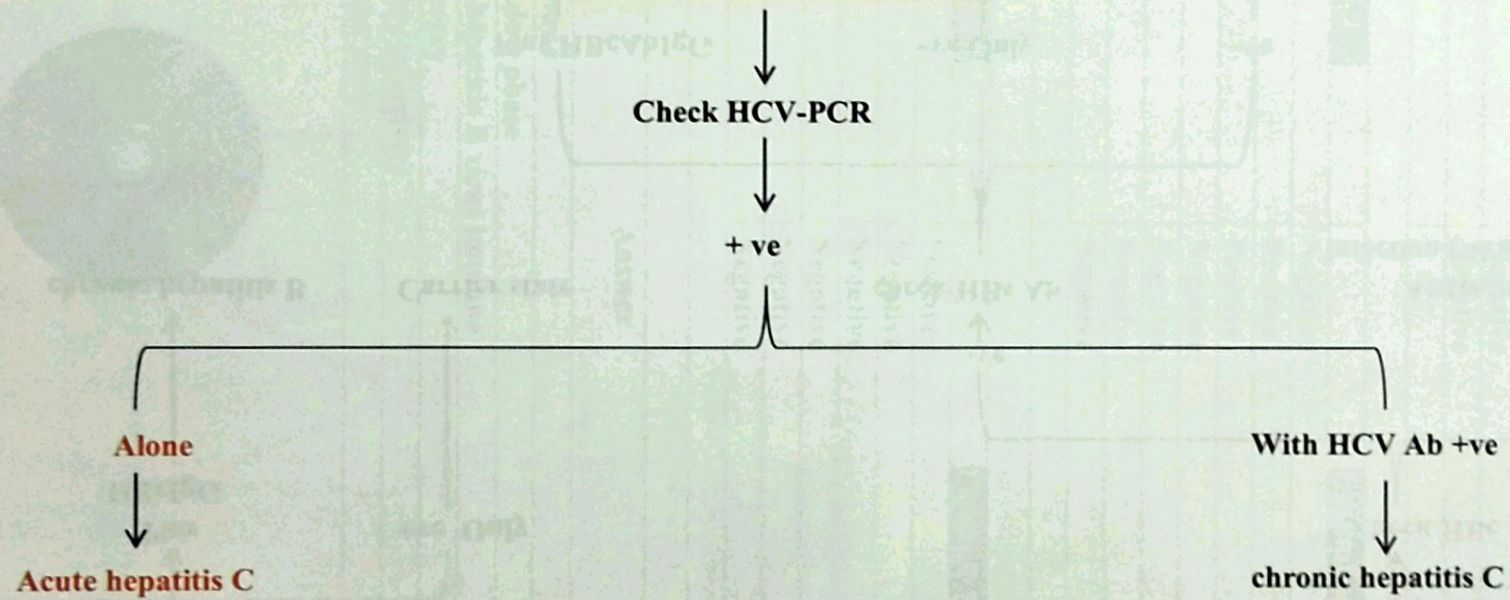




### Diagnostic pathway for Hepatitis A

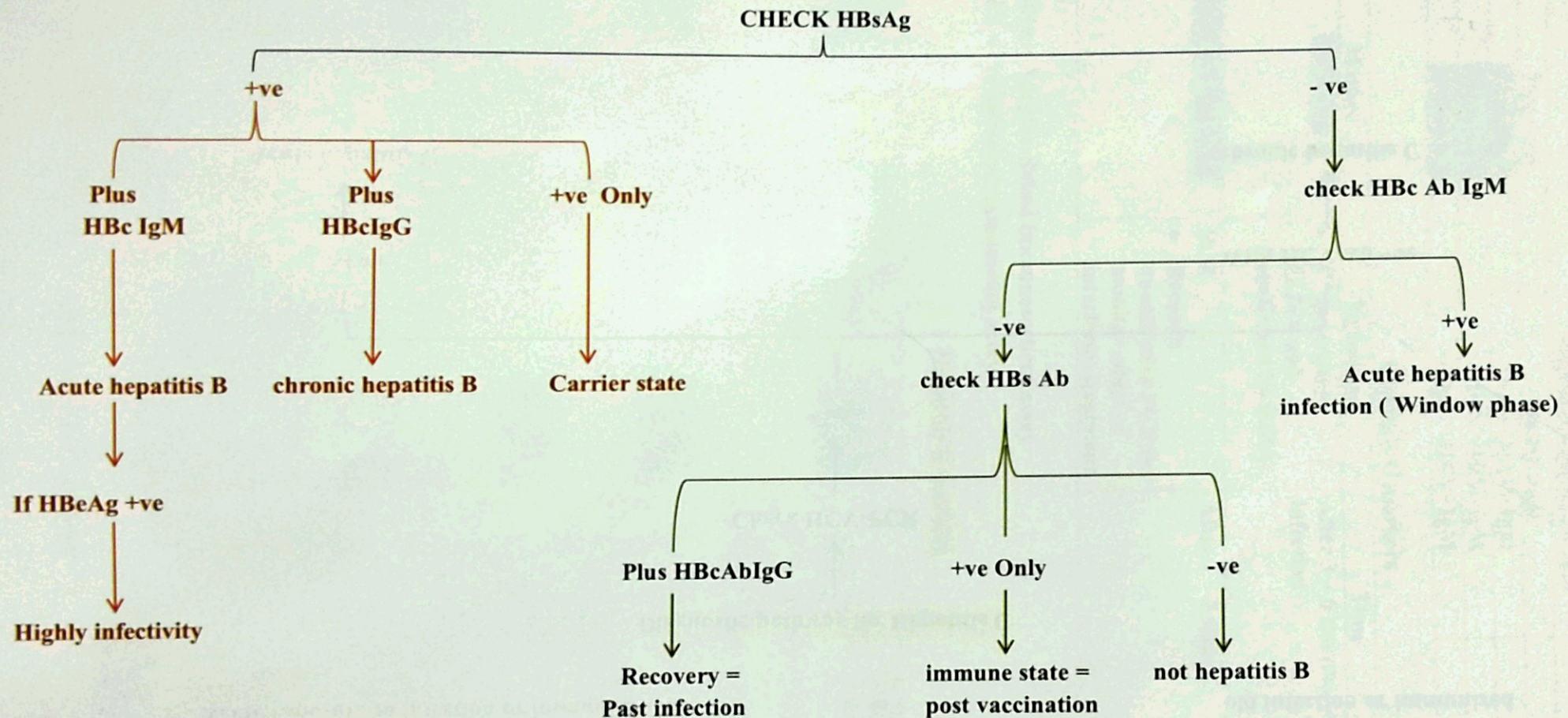


### Diagnostic pathway for Hepatitis C





## Diagnostic pathway for Hepatitis B



NB :

- The period between disappearance of HBsAg and appearance of HBsAb is called window phase
- Patient willing to have vaccine against HBV, what do you ask ?
  - Before : test for HBsAg :
    - If -ve → give vaccination
    - If +ve → don't vaccinate
  - After, follow up HBsAb which should be +ve : successful vaccine, if -ve failed vaccine



## Report Examples of hepatitis markers

|              | <b>Example 1</b> | <b>Example 2</b> |
|--------------|------------------|------------------|
| HBs Ag       | Negative         | Negative         |
| HBs Ab       | Positive         | Negative         |
| HBc Ab (IgG) | Negative         | Positive         |
| HBc Ab (IgM) | Negative         | Positive         |
| HBe Ag       | Negative         | Negative         |
| HBe Ab       | Negative         | Negative         |
| Diagnosis    |                  |                  |

|              | <b>Example 3</b> | <b>Example 4</b> |
|--------------|------------------|------------------|
| HBs Ag       | Negative         | Negative         |
| HBs Ab       | Positive         | Positive         |
| HBc Ab (IgG) | Negative         | Positive         |
| HBc Ab (IgM) | Negative         | Negative         |
| HBe Ag       | Negative         | Negative         |
| HBe Ab       | Negative         | Negative         |
| HC/Ab        | Positive         | Negative         |
| Diagnosis    |                  |                  |

|              | <b>Example 5</b> | <b>Example 6</b> |
|--------------|------------------|------------------|
| HBs Ag       | Positive         | Positive         |
| HBs Ab       | Negative         | Negative         |
| HBc Ab (IgG) | Negative         | Negative         |
| HBc Ab (IgM) | Positive         | Negative         |
| HBe Ag       | Positive         | Negative         |
| HBe Ab       | Negative         | Negative         |
| Diagnosis    |                  |                  |

| Example number | Answer                                         |
|----------------|------------------------------------------------|
| 1              | Hepatitis B virus, immune                      |
| 2              | Acute hepatitis B, window phase                |
| 3              | Chronic hepatitis C – hepatitis B virus immune |
| 4              | Hepatitis B virus, recovery                    |
| 5              | Acute hepatitis B, highly infectivity          |
| 6              | Hepatitis B virus, carrier state               |



**The CD contains MCQs questions for the clinical pathology : HEPATOLOGY MCQS**

|                      |                       |                     |
|----------------------|-----------------------|---------------------|
| Liver function tests | From question no. 241 | To question no. 252 |
| Hepatitis markers    | From question no. 253 | To question no. 266 |



## ORAL GLUCOSE TOLERANCE TEST

### > Indications :

1. Impaired glucose tolerance or impaired fasting glucose
2. Gestational DM
3. Patients with high risk of development of DM
4. Evaluation of unexplained nephropathy , neuropathy or retinopathy
5. Identification of persons with renal or alimentary glucosuria

### > Technique :

#### 1. Before test :

- 1 week before the test , Stop all drugs affecting blood glucose level
- 3 days before the test , normal free diet “ free carbohydrate diet “
- 1 day before the test : Patient is fasting (10 hour – 16 hours fasting)

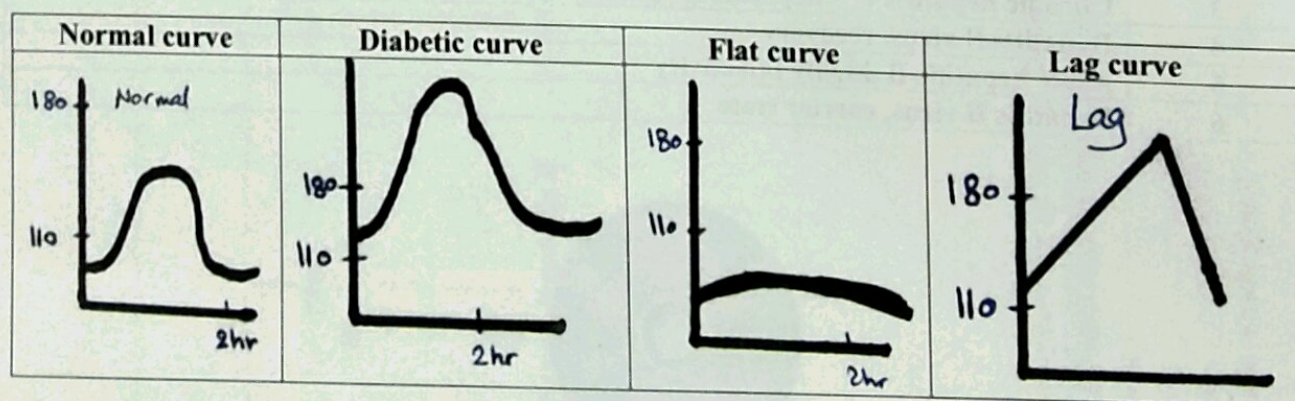
#### 2. Test :

- The test done in the morning and should start between 7 – 9 am
- Take a sample (blood & urine) , while the patient is fasting ,
- Give the patient Oral glucose : 1 g/kg body weight (maximum 75 g) “ 75 gram glucose test”
- During test the patient should be :
  - Complete physical & mental rest
  - No eating or smoking during the test
  - Seated or lying on right side to promote emptying of the stomach
- Every ½ hour blood & urine samples are taken for 2 hours
  - Blood is tested for glucose
  - Urine is tested for glucose and acetone

### > Definitions & Blood sugar curves :

- Normal blood glucose : see below
- D.M : see below
- Impaired glucose tolerance : see below
- Impaired fasting glucose : see below

### ❖ Types of curves :





|                           | Flat curve = increased glucose tolerance                                                                                                                             | Normal        | Renal glucosuria = decreased renal threshold                                        | Lag storage curve = alimentary glucosuria                                                                                                    | Impaired glucose tolerance | Impaired fasting glucose | D.M. curve = decreased glucose tolerance                       |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------|----------------------------------------------------------------|
| Fasting                   | 70 – 110 mg%                                                                                                                                                         | 70 – 110 mg%  | 70 – 110 mg%                                                                        | 70 – 110 mg%                                                                                                                                 | < 126 mg %                 | 110 – 126 mg%            | > 126 mg%                                                      |
| Peak (after 1 hr)         | < 140 mg%                                                                                                                                                            | 140 – 180 mg% | 140 – 180 mg%                                                                       | Peak (early; ½ hr) > 180 mg% (> renal threshold)                                                                                             |                            |                          | > 200 mg%                                                      |
| 2 hour postprandial       | < 140 mg%                                                                                                                                                            | < 140 mg%     | < 140 mg%                                                                           | < 140 mg%                                                                                                                                    | 140 – 200 mg%              | < 140 mg%                | > 200 mg%                                                      |
| Urine samples for glucose | -ve                                                                                                                                                                  | -ve           | +ve                                                                                 | At first -ve then +ve i.e. +ve in the peak only                                                                                              | -ve                        | -ve                      | + ve                                                           |
| Urine samples for acetone | -ve                                                                                                                                                                  | -ve           |                                                                                     |                                                                                                                                              | -ve                        | -ve                      | If +ve → DKA                                                   |
| Causes                    | <ul style="list-style-type: none"> <li>• Insulinoma</li> <li>• Addison disease</li> <li>• Panhypopituitarism</li> <li>• Malabsorption</li> <li>• myxedema</li> </ul> |               | <ul style="list-style-type: none"> <li>• idiopathic</li> <li>• pregnancy</li> </ul> | <ul style="list-style-type: none"> <li>• gastric surgery e.g. gastrectomy</li> <li>• thyrotoxicosis</li> <li>• liver cell failure</li> </ul> |                            |                          | NB : random plasma glucose ≥ 200 mg % + classic symptoms of DM |

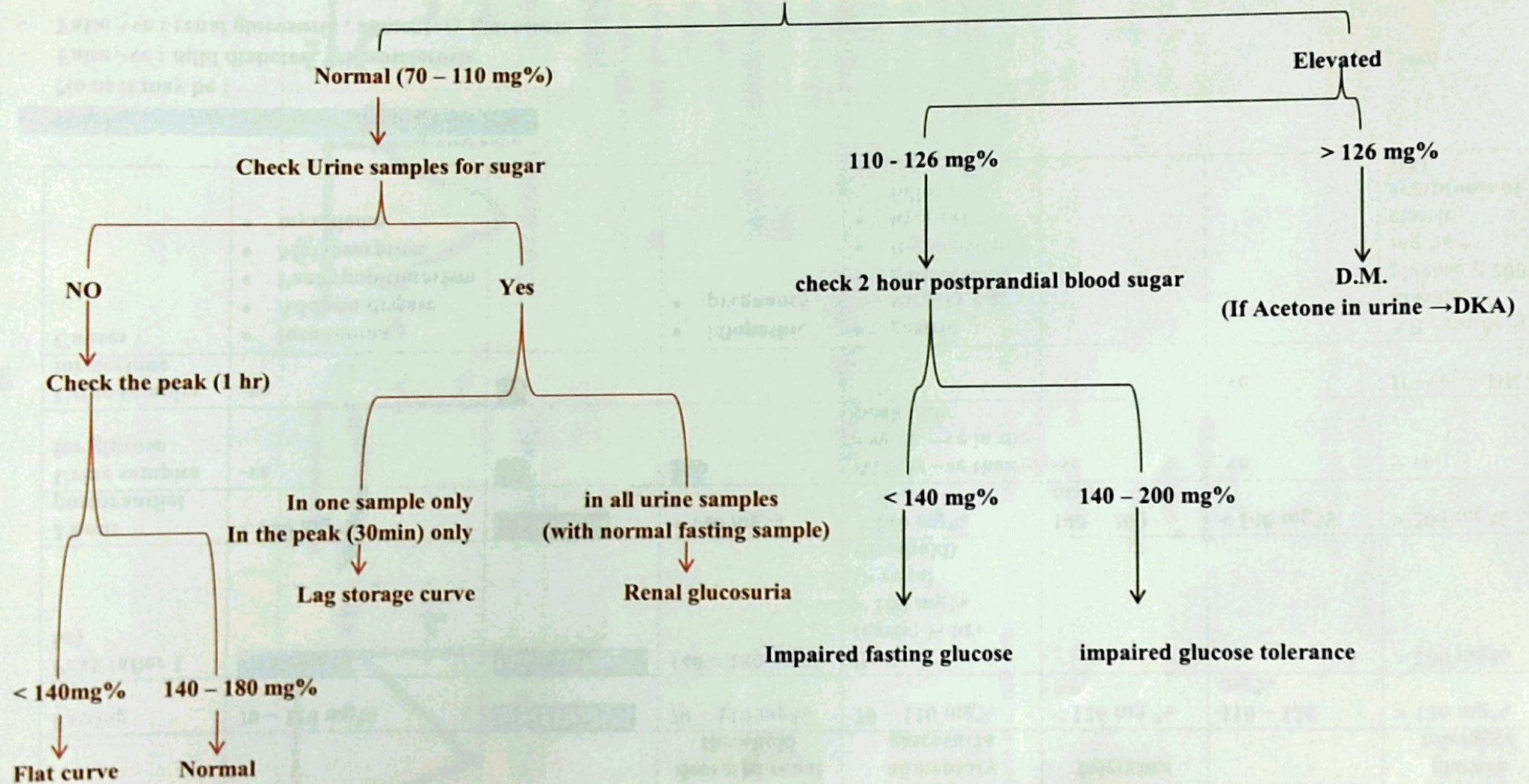
• Is urine analysis reliable for diagnosis for DM ?

No as it may be :

- False -ve : mild diabetes , atherosclerosis
- False +ve : renal glucosuria , alimentary glucosuria



**Diagnostic pathway for DM**  
**Check fasting plasma glucose level**





## Report Examples :

| Example 1           |           |       |        |
|---------------------|-----------|-------|--------|
|                     | Blood     | Urine |        |
|                     |           | Sugar | Ketone |
| Fasting blood sugar | 200 mg/dl | +     | Nil    |
| 30 min              | 280 mg/dl | ++    | Nil    |
| 60 min              | 310 mg/dl | ++    | Nil    |
| 90 min              | 450 mg/dl | +++   | +      |
| 120 min             | 500 mg/dl | ++++  | +      |
| Diagnosis           |           |       |        |

| Example 2           |           |       |        |
|---------------------|-----------|-------|--------|
|                     | Blood     | Urine |        |
|                     |           | Sugar | Ketone |
| Fasting blood sugar | 90 mg/dl  | Nil   | Nil    |
| 30 min              | 110 mg/dl | +     | Nil    |
| 60 min              | 160 mg/dl | +     | Nil    |
| 90 min              | 140 mg/dl | +     | Nil    |
| 120 min             | 100 mg/dl | +     | Nil    |
| Diagnosis           |           |       |        |

| Example 3           |           |       |        |
|---------------------|-----------|-------|--------|
|                     | Blood     | Urine |        |
|                     |           | Sugar | Ketone |
| Fasting blood sugar | 90 mg/dl  | Nil   | Nil    |
| 30 min              | 100 mg/dl | Nil   | Nil    |
| 60 min              | 120 mg/dl | Nil   | Nil    |
| 90 min              | 95 mg/dl  | Nil   | Nil    |
| 120 min             | 80 mg/dl  | Nil   | Nil    |
| Diagnosis           |           |       |        |

| Example 3           |           |       |        |
|---------------------|-----------|-------|--------|
|                     | Blood     | Urine |        |
|                     |           | Sugar | Ketone |
| Fasting blood sugar | 90 mg/dl  | Nil   | Nil    |
| 30 min              | 100 mg/dl | Nil   | Nil    |
| 60 min              | 120 mg/dl | Nil   | Nil    |
| 90 min              | 95 mg/dl  | Nil   | Nil    |
| 120 min             | 80 mg/dl  | Nil   | Nil    |
| Diagnosis           |           |       |        |

| Example 4           |           |       |        |
|---------------------|-----------|-------|--------|
|                     | Blood     | Urine |        |
|                     |           | Sugar | Ketone |
| Fasting blood sugar | 80 mg/dl  | Nil   | Nil    |
| 30 min              | 200 mg/dl | +     | Nil    |
| 60 min              | 80 mg/dl  | Nil   | Nil    |
| 90 min              | 50 mg/dl  | Nil   | Nil    |
| 120 min             | 90 mg/dl  | Nil   | Nil    |
| Diagnosis           |           |       |        |



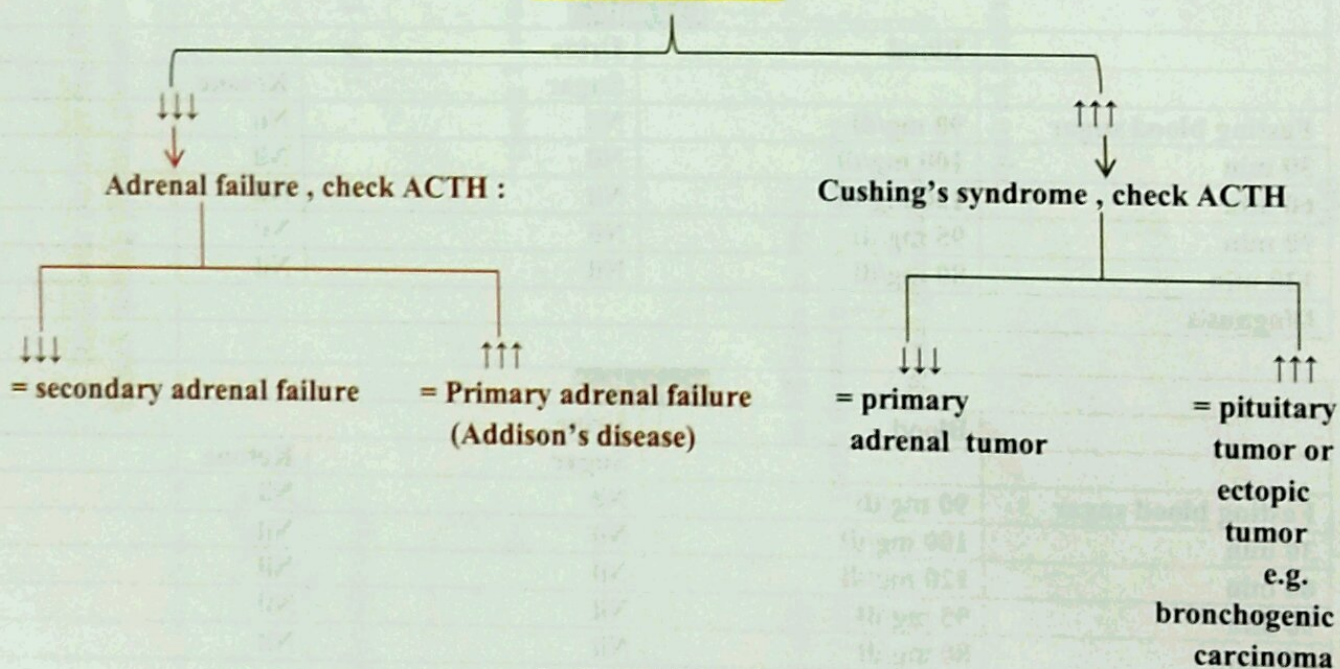
### Example 5

|                     | Blood     | Urine |        |
|---------------------|-----------|-------|--------|
|                     |           | Sugar | Ketone |
| Fasting blood sugar | 130 mg/dl | Nil   | Nil    |
| 30 min              | 180 mg/dl | Nil   | Nil    |
| 60 min              | 170 mg/dl | Nil   | Nil    |
| 90 min              | 170 mg/dl | Nil   | Nil    |
| 120 min             | 150 mg/dl | Nil   | Nil    |
| Diagnosis           |           |       |        |

| Example number | Answer                     |
|----------------|----------------------------|
| 1              | Sever D.M (DKA)            |
| 2              | Renal glucosuria           |
| 3              | Flat curve                 |
| 4              | Lag curve                  |
| 5              | Impaired glucose tolerance |

### ❖ Adrenal function test

#### Check cortisol level



### ❖ Thyroid function test

|             | Normal               |
|-------------|----------------------|
| TSH         | 2- 10 units          |
| T4          | 5 – 12 µg%           |
| T3          | 115 – 190 nanogram % |
| Cholesterol | 150 – 250 mg %       |



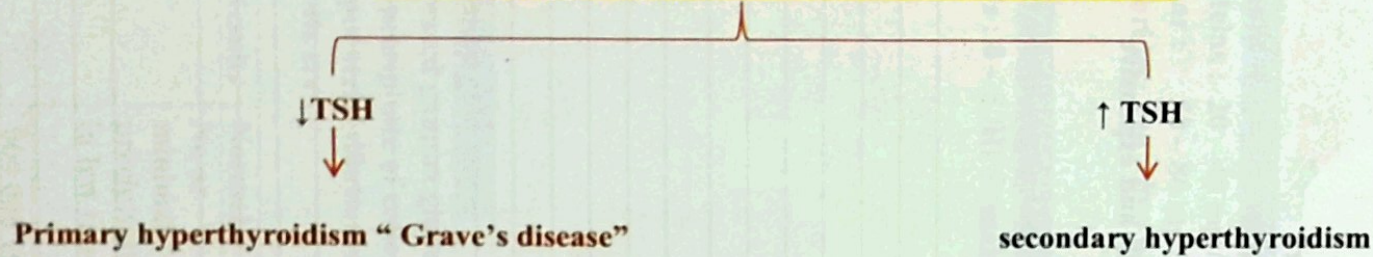
The CD contains MCQs questions for the clinical pathology : **ENDOCRINOLOGY MCQS**

|                             |                       |                     |
|-----------------------------|-----------------------|---------------------|
| Oral glucose tolerance test | From question no. 267 | To question no. 276 |
| Thyroid function test       | From question no. 277 | To question no. 286 |



### Diagnostic pathway for thyroid profile:

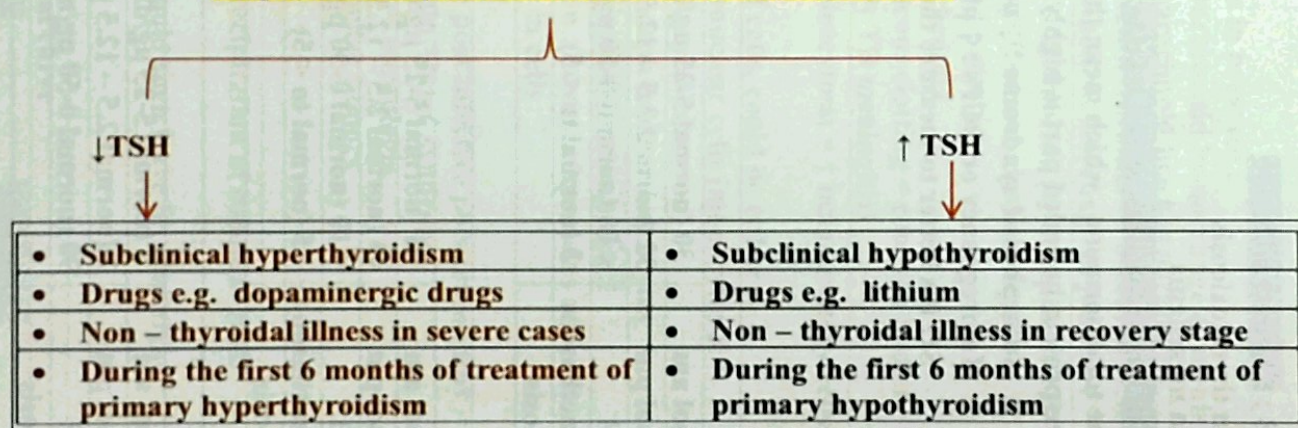
**Suspected Hyperthyroidism =  $\uparrow\uparrow\uparrow$  T3 & T4 , check TSH :**



**Suspected Hypothyroidism =  $\downarrow\downarrow\downarrow$  T3 & T4 , check TSH :**



**Suspected Euthyroid = normal T3 & T4, check TSH :**





Report examples  
Thyroid function tests

|           | Example 1   | Example 2 | Example 3     | Normal value |
|-----------|-------------|-----------|---------------|--------------|
| FT3       | 0.4 pg/dl   | 0.5 pg/dl | 6.7 pg/dl     | 1.3-5        |
| FT4       | 0.2 pg/dl   | 0.2 pg/   | 4.9 pg/dl     | 0.8-2        |
| TSH       | > 75 uIU/ml | > 50      | < 0.01 uIU/ml | 0.3-5        |
| Diagnosis |             |           |               |              |

❖ NB : **Cholesterol level :**

- ↓ in thyrotoxicosis
- ↑ in myxedema

❖ **Which is better, measuring total or free part of thyroid hormone ? Free**

- The total hormone , which mean the free part & the protein bounded part
  - The protein bounded part is highly affected by the level of plasma proteins :
    - In nephrotic syndrome : ↓ plasma proteins : false myxedema
    - In pregnancy or OCPs : ↑ plasma proteins : false thyrotoxicosis
- SO it's better to measure the free part of T3 & T4 which is difficult and expensive

Adrenal function tests

| Example 1     |                              |
|---------------|------------------------------|
| Cortisol am   | 30 (normal 5-25 µg/dl)       |
| Cortisol pm   | 32 (normal 2.5 – 12.5 µg/dl) |
| ACTH          | < 10 (normal 0-50 pg/ml)     |
| Dexamethasone | 3 (normal to < 5)            |
| Diagnosis     |                              |

| Example 2     |                              |
|---------------|------------------------------|
| Cortisol am   | 41 (normal 5-25 µg/dl)       |
| Cortisol pm   | 43 (normal 2.5 – 12.5 µg/dl) |
| ACTH          | < 10 (normal 0-50 pg/ml)     |
| Dexamethasone | 15 (normal to < 5)           |
| Diagnosis     |                              |

| Example 3   |                             |
|-------------|-----------------------------|
| Cortisol am | 1 (normal 5-25 µg/dl)       |
| Cortisol pm | 1 (normal 2.5 – 12.5 µg/dl) |
| ACTH        | 90 (normal 0-50 pg/ml)      |
| Diagnosis   |                             |

| Example number         | Answer                                       |
|------------------------|----------------------------------------------|
| Thyroid function tests |                                              |
| 1                      | 1ry hypothyroidism                           |
| 2                      | 1ry hypothyroidism                           |
| 3                      | 1ry hyperthyroidism                          |
| Adrenal function tests |                                              |
| 1                      | Cushing (adrenal hyperplasia)                |
| 2                      | Cushing (adrenal adenoma )                   |
| 3                      | Primary adrenal failure ( Addison's disease) |

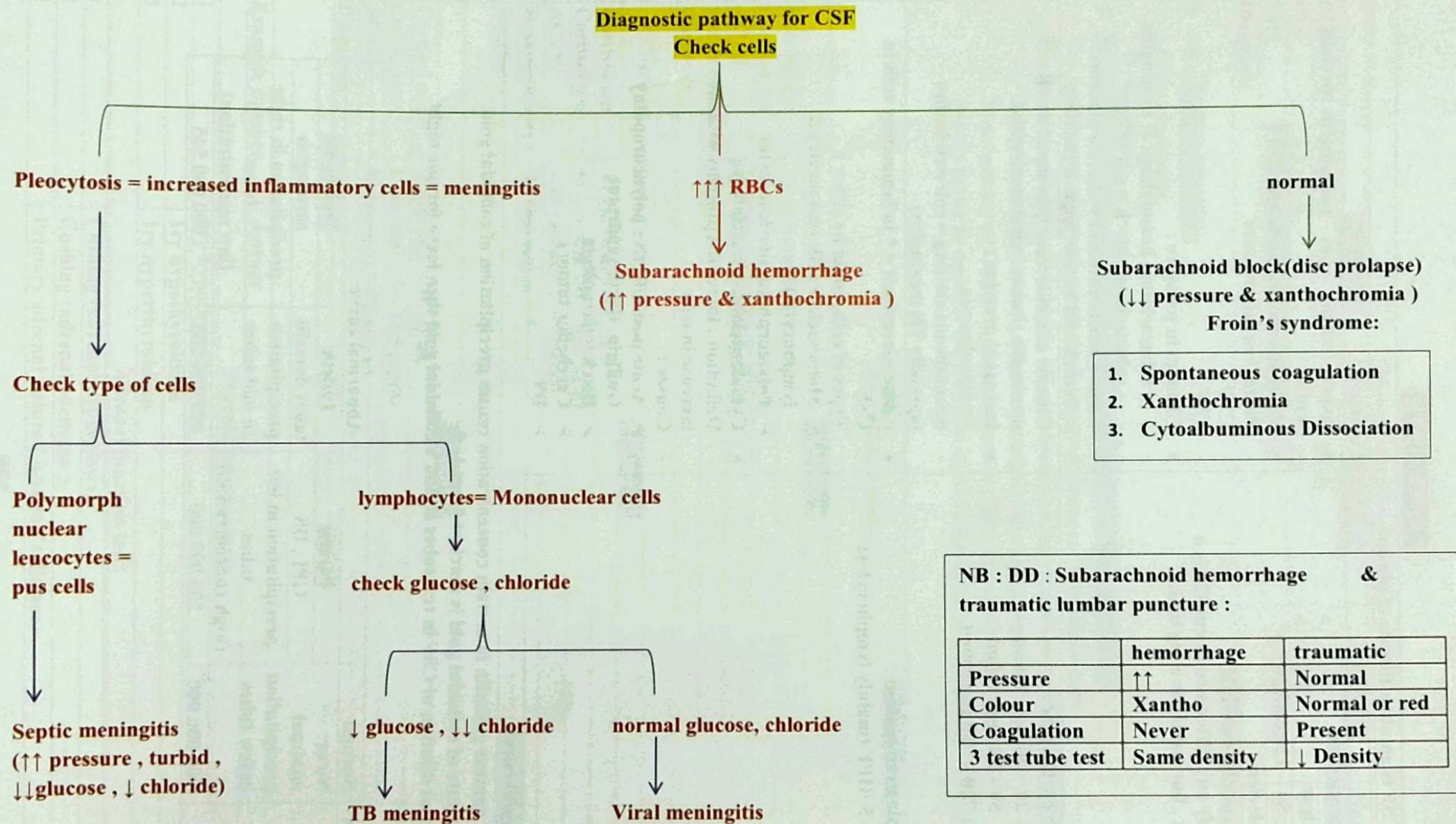


## CSF ANALYSIS

|                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b> : CSF is an ultra-filtrate of plasma                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Normally</b>                                                                                                                                                                                                                                                                                                                                                            | <b>Comment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>1. Physical properties</b> <ul style="list-style-type: none"> <li>Aspect : clear</li> <li>Pressure : 80 – 120 cmH<sub>2</sub>O</li> <li>Color : colorless</li> <li>❖ <b>Why pressure by cmH<sub>2</sub>O?</b> <ul style="list-style-type: none"> <li>To magnify any difference as cmH<sub>2</sub>O is a small unit , but mmHg is a big unit.</li> </ul> </li> </ul>     | <ul style="list-style-type: none"> <li>Aspect : turbid = pus → meningitis specially septic.</li> <li><b>What else measured by cmH<sub>2</sub>O ?</b> <ul style="list-style-type: none"> <li>Portal venous pressure</li> <li>CVP</li> <li>CSF</li> </ul> </li> <li>Changes in pressure :                             <ul style="list-style-type: none"> <li>↑ → subarachnoid hemorrhage &amp; meningitis</li> <li>↓ → subarachnoid block = paraplegia</li> </ul> </li> <li>Color : xanthochromia → excess proteins, subarachnoid hemorrhage &amp; jaundice</li> </ul>                                                                                                                                                                                                                                                         |
| <b>2. Chemical constituents :</b> <ul style="list-style-type: none"> <li>Proteins : 20 – 40 mg / 100ml</li> <li>Sugar : 50 – 80 mg / 100ml</li> <li>Chlorides: 720 – 750 mg/100ml</li> </ul>                                                                                                                                                                               | <ul style="list-style-type: none"> <li>Glucose and chloride : ↓ in septic &amp; TB meningitis (but not viral meningitis)</li> <li>Increased proteins :                             <ul style="list-style-type: none"> <li>Xanthochromia</li> <li>Spontaneous clotting = cob web bodies (specially TB meningitis)</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>3. Microscopic examination :</b> <ul style="list-style-type: none"> <li>Cells : 0 – 5 /HPF (mainly lymphocytes)</li> </ul>                                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li><b>Cells</b> : pleocytosis = ↑ inflammatory cells in CSF                             <ul style="list-style-type: none"> <li>Types of cells, could be either :                                     <ul style="list-style-type: none"> <li>➤ Mononuclear cells (monocytes &amp; lymphocytes) or</li> <li>➤ Polymorph nuclear leucocytes</li> </ul> </li> </ul> </li> <li><b>Cytoalbuminous dissociation :</b> <ul style="list-style-type: none"> <li>Definition : increased proteins without increase in cells</li> <li>Causes :                                     <ul style="list-style-type: none"> <li>➤ Acute post infective polyneuropathy = Guillain-Barré syndrome</li> <li>➤ Block = paraplegia</li> <li>➤ Cerebellar tumors</li> <li>➤ DS</li> </ul> </li> </ul> </li> </ul> |
| <b>4. Colloidal gold curve</b> <ul style="list-style-type: none"> <li>Increased gamma globulin in certain concentration causes precipitation of colloidal gold.</li> <li>The precipitate of colloidal gold is marked from 1- 5</li> <li>We put serial dilution of CSF in test tubes &amp; add a colloidal gold then leave for one night.</li> <li>Results are :</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Results | Normal                                   | Abnormal curve                                      |                            |                                                     |
|---------|------------------------------------------|-----------------------------------------------------|----------------------------|-----------------------------------------------------|
|         | No or minimal precipitation in few tubes | <b>Paretic</b>                                      | <b>Tabetic</b>             | <b>Meningitic</b>                                   |
|         |                                          | GPI , DS                                            | tabes dorsalis             | meningitis                                          |
|         |                                          | precipitation in left tubes<br>(high concentration) | precipitation in mid tubes | precipitation in right tubes<br>(low concentration) |
|         |                                          | 000 000 000                                         | 000 454 000                | 000 000 545                                         |







### Report example for CSF :

| Example 1 |                                      |
|-----------|--------------------------------------|
| Aspect    | Turbid                               |
| Colour    | Colourless                           |
| Proteins  | 150 mg/dl (15 – 45 mg/dl)            |
| Sugar     | 5 mg/dl (45 – 80 mg/dl)              |
| Choride   | 115 mmol/l (115 – 130 mmol/l)        |
| Cells     | 300 cell/ $\mu$ l (polumorphnuclear) |
| Diagnosis |                                      |

| Example 2 |                               |
|-----------|-------------------------------|
| Aspect    | clear                         |
| Colour    | xanthochromic                 |
| Proteins  | 200 mg/dl (15 – 45 mg/dl)     |
| Sugar     | 65 mg/dl (45 – 80 mg/dl)      |
| Choride   | 120 mmol/l (115 – 130 mmol/l) |
| Cells     | 5 cell/ $\mu$ l (mononuclear) |
| Diagnosis |                               |

| Example 3 |                                |
|-----------|--------------------------------|
| Aspect    | clear                          |
| Colour    | colourless                     |
| Proteins  | 40 mg/dl (15 – 45 mg/dl)       |
| Sugar     | 60 mg/dl (45 – 80 mg/dl)       |
| Choride   | 125 mmol/l (115 – 130 mmol/l)  |
| Cells     | 90 cell/ $\mu$ l (lymphocytes) |
| Diagnosis |                                |

| Example | Answer               |
|---------|----------------------|
| 1       | Bacterial meningitis |
| 2       | Xanthochromia        |
| 3       | Viral meningitis     |



| The CD contains MCQs questions for the clinical pathology : NEUROLOGY MCQS |                       |                     |
|----------------------------------------------------------------------------|-----------------------|---------------------|
| CSF analysis                                                               | From question no. 287 | To question no. 293 |



## REPORT OF ACUTE MYOCARDIAL INFARCTION

|    | ➤ <b>Non-specific Enzymes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ➤ <b>Specific; Isoenzymes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | <ul style="list-style-type: none"> <li>• <b>CPK = CK; Creatinine PhosphoKinase :</b><br/>Found in cardiac muscle , skeletal muscle , brain</li> <li>• <b>Causes of increased total CPK activity :</b> <ul style="list-style-type: none"> <li>- Myocardial infarction</li> <li>- Muscular dystrophy</li> <li>- Muscle trauma e.g. IM injection</li> <li>- Severe exercise</li> <li>- Hypothyroidism</li> </ul> </li> </ul>                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>• CPK has 2 subunits : M , B</li> <li>- In heart only : CPK MB</li> <li>- In muscle only : CPK MM</li> <li>- In brain : CPK BB</li> <li>✓ SO, ... If you suspect myocardial infarction look for CPK MB ( Normal CPK MB = &lt; 6 % of total CK)</li> </ul>                                                                                                                                                                             |
| 2. | <ul style="list-style-type: none"> <li>• <b>LDH = LD ; lactate dehydrogenase :</b><br/>found in cardiac muscle , skeletal muscle , liver , kidney , &amp; erythrocytes</li> <li>• <b>Causes of increased LDH activity :</b> <ul style="list-style-type: none"> <li>- Myocardial infarction</li> <li>- Megaloblastic anemia</li> <li>- Malignancy</li> <li>- Hepatocellular disorders</li> <li>- Hemolysis</li> <li>- Pulmonary infarction</li> </ul> </li> </ul>                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Has five isoenzymes : LDH 1 , LDH 2, LDH 3, LDH 4, LDH 5</li> <li>- In heart only LDH 1</li> <li>- In liver only : LDH 5</li> <li>✓ SO, ... If you suspect myocardial infarction look for LDH1</li> </ul>                                                                                                                                                                                                                           |
| 3. | <ul style="list-style-type: none"> <li>• <b>SGOT = AST :</b><br/>found in cardiac muscle , skeletal muscles , liver , kidney , &amp; erythrocytes</li> <li>✓ So look for SGPT = ALT which is specific to liver : <ul style="list-style-type: none"> <li>- If high : origin of SGOT is liver</li> <li>- If normal : origin of SGOT is heart</li> </ul> </li> <li>• <b>Causes of increased AST activity :</b> <ul style="list-style-type: none"> <li>- Myocardial infarction</li> <li>- Muscular dystrophy</li> <li>- Hemolysis</li> <li>- Acute and chronic liver damage</li> <li>- Acute pancreatitis</li> <li>- Renal infarction</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• No isoenzymes</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                            |
| 4. | <ul style="list-style-type: none"> <li>• <b>Myoglobin :</b> <ul style="list-style-type: none"> <li>- Is a low molecular weight haem protein found in cardiac and skeletal muscles</li> </ul> </li> <li>• <b>Causes of increased myoglobin :</b> <ul style="list-style-type: none"> <li>- Trauma either to skeletal or cardiac muscles as in crush injuries and acute myocardial infarction</li> </ul> </li> </ul>                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 5. | <ul style="list-style-type: none"> <li>• <b>Troponins :</b> <ul style="list-style-type: none"> <li>- The contractile proteins of all myofibrils include the regulatory proteins troponin .</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>• Troponin is a complex of three protein subunits : <ol style="list-style-type: none"> <li>1. Troponin C ; the calcium binding component</li> <li>2. Troponin I ; the inhibitory component = TnI</li> <li>3. Troponin T ; the tropomyosin binding component = TnT</li> </ol> </li> <li>❖ Cardiac specific troponins = cTn (cTnI &amp; cTnT)</li> <li>✓ SO, ... If you suspect myocardial infarction look for TnI &amp; TnT</li> </ul> |



❖ **Cardiac markers pattern in AMI :**

|           | Initial rise | Peak                                                                      | Back to normal |
|-----------|--------------|---------------------------------------------------------------------------|----------------|
| Total CPK | 4 – 8 hr     | 12 – 24 hr                                                                | 3 -5 days      |
| CK-MB     | 3 – 8 hr     | 12 – 24 hr                                                                | 2 – 3 days     |
| LDH       | 10 – 12 hr   | 48 – 72 hr                                                                | 5 – 14 days    |
| AST       | 6 – 12 hr    | 18 – 36 hr                                                                | 4 – 6 days     |
| Myoglobin | 1-3 hr       | 6 – 9 hr                                                                  | 1 day          |
| cTnI      | 3- 8 hr      | 24 – 48 hr                                                                | 3 – 5 days     |
| cTnT      | 3- 8 hr      | 24 – 48 hr ( 1 <sup>st</sup> peak)<br>72 – 100 hr ( 2 <sup>nd</sup> peak) | 5 – 10 days    |

## Examples for Cardiac profiles :

| Example 1 |                              |
|-----------|------------------------------|
| CK        | 140 U/L ( Normal : 0 – 170 ) |
| CK MB     | 20 U/L ( normal 0 – 24 )     |
| SGOT      | 30 U/L ( normal 0 – 32 )     |
| LDH       | 790 U/L ( normal 240 – 480 ) |
| Diagnosis |                              |

| Example 2 |                              |
|-----------|------------------------------|
| CK        | 300 U/L ( Normal : 0 – 170 ) |
| CK MB     | 40 U/L ( normal 0 - 24 )     |
| SGOT      | 23 U/L ( normal 0 – 32 )     |
| LDH       | 360 U/L ( normal 240 – 480 ) |
| Diagnosis |                              |

❖ **Diagnosis of MI :**

- Typical chest pain of infarction
- ECG of MI; pathological Q wave
- Enzymes elevation

❖ **Importance of enzymes :**

- Confirm diagnosis of MI in special types
  - Painless MI
  - Non-Q wave infarction “ subendocardial infarction”
- Timing of infarction
- Detect efficacy of thrombolytic therapy

| Example number | Answer                                                                                           |
|----------------|--------------------------------------------------------------------------------------------------|
| 1              | Elevated LDH for DD e.g. myocardial infarction after 1 week or pulmonary infarction or hemolysis |
| 2              | Recent myocardial infarction                                                                     |



| The CD contains MCQs questions for the clinical pathology : CARDIOLOGY MCQS |                       |                     |
|-----------------------------------------------------------------------------|-----------------------|---------------------|
| Myocardial infarction                                                       | From question no. 294 | To question no. 300 |



## SEROLOGY TESTS

### 1. Widal test :

- Definition:** agglutination test for diagnosis of salmonella infection (typhoid & paratyphoid)

| Antigens                                                                                       | Antibodies                                                                                 |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| - Somatic antigen (O Ag) : non-specific, same for all types                                    | - O antibodies : recent acute infections : non-specific, same for all types                |
| - Flagellar antigen (H Ag) : specific for each type ( typhoid , paratyphoid A , paratyphoid B) | - H antibodies : old infections & vaccination , persists for life & specific for each type |

- Normal antibodies titre :**

|                        | Normal       |
|------------------------|--------------|
| Anti - O               | 1/40 - 1/80  |
| Anti - H typhoid       | 1/40 - 1/80  |
| Anti - H paratyphoid A | 1/80 - 1/100 |
| Anti - H paratyphoid B | 1/80 - 1/100 |

- Drawbacks of Widal test :**

- Only Positive from second week
- Needs Rising titre which is more important for diagnosis than single high titre
- Affected by antibiotic therapy

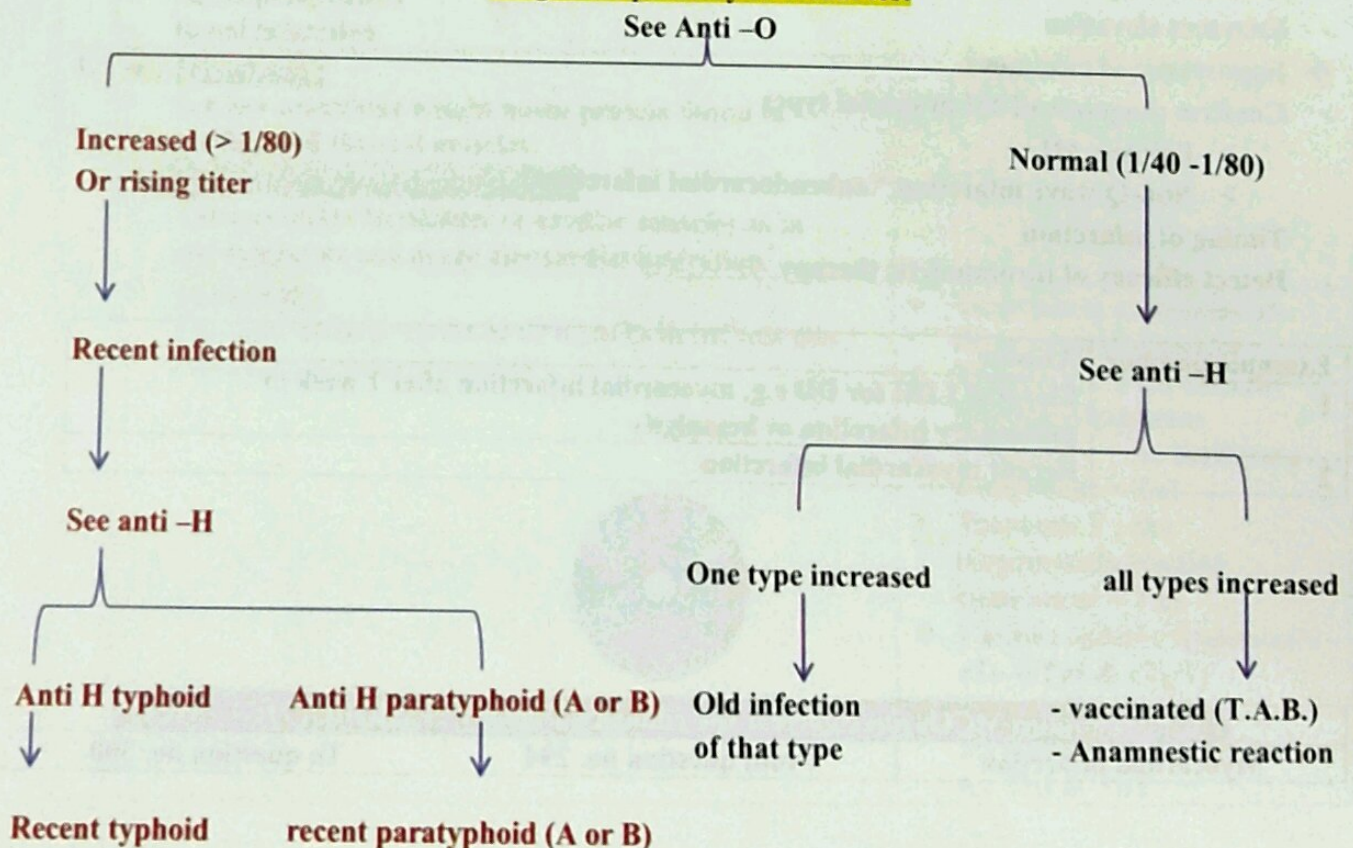
- Salmonella is better diagnosed by detection of antigens by culture from**

- Blood in 1<sup>st</sup> week
- Stool in 2<sup>nd</sup> week
- Urine in 3<sup>rd</sup> week

- NBs :**

- Vi (virulence) antibody is the last to rise & its persistence indicates a carrier state
- Anamnestic reaction : improper antibody response to non-related antigen caused by febrile illness causing sharpe rise of H antibody and low O titre

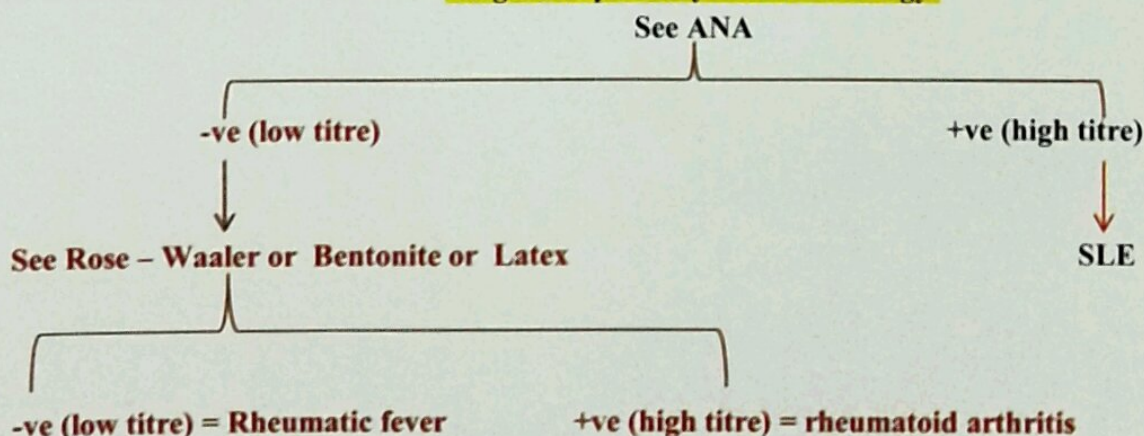
### Diagnostic pathway of Widal test





|                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>2. Brucella agglutination :</b> <ul style="list-style-type: none"> <li>• Positive in brucellosis from second week</li> <li>• A titre &gt; 1/160 is diagnostic especially if rising</li> </ul>                                                                                                                                                   |
| <b>3. Paul – Bunel &amp; monospot test :</b> <ul style="list-style-type: none"> <li>• Positive in infectious mononucleosis</li> <li>• Serum contain heterophil Ab agglutinating sheep RBCs</li> </ul>                                                                                                                                              |
| <b>4. Weil – Felic test :</b> <ul style="list-style-type: none"> <li>• Positive in typhus</li> </ul>                                                                                                                                                                                                                                               |
| <b>5. Rose – Waaler , Bentonite &amp; Latex test :</b> <ul style="list-style-type: none"> <li>• 3 serological test to detect Rheumatoid factor</li> <li>• Rheumatoid factor is a collection of autoantibodies including IgM formed against altered IgG , RF is not specific may be present in many conditions e.g. rheumatoid arthritis</li> </ul> |
| <b>6. Antistreptolysin O titre : ASOT</b> <ul style="list-style-type: none"> <li>• Normally &lt; 250 Todd's unit</li> <li>• Positive in recent streptococcal infection (better rising titre)<br/>e.g. In rheumatic fever , glomerulonephritis , pharyngitis , tonsillitis , scarlet fever</li> </ul>                                               |
| <b>7. C-reactive protein : CRP :</b> <ul style="list-style-type: none"> <li>• Normal absent , it's graded from +1 → +4</li> <li>• Positive in tissue damage (acute phase reactant; in acute and chronic conditions)</li> </ul>                                                                                                                     |
| <b>8. Coomb's test : for immune hemolytic reaction</b> <ul style="list-style-type: none"> <li>- Direct : detect fixed RBCs Ab</li> <li>- Indirect : detect free RBCs Ab in serum (severe cases)</li> </ul>                                                                                                                                         |
| <b>9. Antinuclear antibodies : ANA for SLE</b>                                                                                                                                                                                                                                                                                                     |
| <b>10. ESR : See blood</b>                                                                                                                                                                                                                                                                                                                         |
| <b>❖ Skin tests :</b> <ul style="list-style-type: none"> <li>A. Tuberculin for TB</li> <li>B. Casoni test for hydatid disease</li> <li>C. Kveim test for sarcoidosis</li> <li>D. Schik test for detection of non-immune Diphtheria</li> <li>E. Dick test for scarlet fever</li> </ul>                                                              |
| <b>❖ Media :</b> <ul style="list-style-type: none"> <li>A. Lowenstein Jensen medium for TB</li> <li>B. Loeffler's medium for diphtheria</li> </ul>                                                                                                                                                                                                 |
| <b>❖ Stains :</b> <ul style="list-style-type: none"> <li>A. Gram stains</li> <li>B. Ziehl-Neelsen stain for TB</li> <li>C. Modified Ziehl-Neelsen stain for TB</li> <li>D. Giemsa stains for malaria</li> </ul>                                                                                                                                    |

**Diagnostic pathway of rheumatology:**





### Report example for Serology:

|                | Normal       | Example 1 | Example 2 | Example 3 |
|----------------|--------------|-----------|-----------|-----------|
| Anti O         | 1/40 - 1/80  | 1/120     | 1/40      | 1/40      |
| Anti H typhoid | 1/40 - 1/80  | 1/160     | 1/40      | 1/160     |
| Anti H Para A  | 1/80 - 1/100 | 1/100     | 1/250     | 1/250     |
| Anti H Para B  | 1/80 - 1/100 | 1/100     | 1/100     | 1/250     |
| Diagnosis      |              |           |           |           |

|             | Normal             | Example 4 | Example 5 | Example 6 |
|-------------|--------------------|-----------|-----------|-----------|
| ESR         | 4 - 7 (westergren) | 110       | 80        | 90        |
| CRP         | -ve                | +4        | +3        | -ve       |
| ASOT        | < 200 Todd's units | 700       | 100       | 80        |
| Rose Waaler | -ve < 1/32         | < 1/32    | 1/64      | 1/32      |
| ANA         | -ve                | -ve       | -ve       | +ve       |
| Diagnosis   |                    |           |           |           |

| Example number | Answer                                              |
|----------------|-----------------------------------------------------|
| 1              | Recent typhoid infection                            |
| 2              | Old paratyphoid type A                              |
| 3              | Vaccinated (TAB)                                    |
| 4              | Recent streptococcal infection e.g. rheumatic fever |
| 5              | Rheumatoid arthritis                                |
| 6              | Systemic lupus erythematosus                        |



| The CD contains MCQs questions for the clinical pathology : SEROLOGY & IMMUNOLOGY MCQS |                       |                     |
|----------------------------------------------------------------------------------------|-----------------------|---------------------|
| Serology & immunology                                                                  | From question no. 301 | To question no. 339 |



## STOOL ANALYSIS

❖ Normal :

### 1. Volume :

- $\leq 200$  gm /day unless excess dietary fibers are ingested
- Diarrhea : Loose stool or frequent motion  $> 4$  times / day or both
- Constipation : infrequent bowel evacuation( $> 48$  hr.) and passage of hard small stools

2. Consistency : soft , well formed

3. Colour : light to dark brown

4. Odour : fecal (not offensive)

5. Reaction : alkaline

### 6. Contents :

- Mucus , pus , RBCs : absent
- Fat :  $< 6$  gm / day

### Diagnostic pathway

See fat content

Normal  $\leq 6$  gm / day

increased  $> 6$  gm/day or  $> 25\%$  of total weight

Look for RBCs if +ve = Dysentery

See pus cells and mucus

Malabsorption syndrome  
(Steatorrhea)

Mainly split fat

mainly unsplit  $> 25\%$

Malabsorption  
(intestinal)

Mal-digestion  
(Pancreatic  
hepatobiliary)

|           | Amebic dysentery                | Bacillary dysentery |
|-----------|---------------------------------|---------------------|
| Pus cells | ++                              | ++++                |
| Mucus     | ++++                            | ++                  |
|           | Amebic cyst or vegetative forms | Gram -ve bacilli    |



# Report examples for stool analysis :

|                 | normal            | Example 1     | Example 2      | Example 3 | Example 4        |
|-----------------|-------------------|---------------|----------------|-----------|------------------|
| Volume          | 200 gm/day        | 180           | 300            | 350       | 350              |
| Consistency     | Soft, well formed | Loose         | Loose (watery) | Loose     |                  |
| Colour          | Brown             | Brown         |                |           |                  |
| Odour           | Fecal             | Offensive     | Offensive      | Offensive | Offensive        |
| Reaction        | Alkaline          | Acidic        | Alkaline       | Alkaline  | Alkaline         |
| • Contents :    |                   |               |                |           |                  |
| - Mucus         | ---               | Excess , ++++ | Slight +       | Slight +  | Slight +         |
| - Pus cells     | ---               | ++            | ++++           | ---       | ---              |
| - RBCs          | ---               | +++           | +++            | ---       | ---              |
| - Food residues | ---               | +             | +              | ++        | ++ (meat fibers) |
| - Others        | ---               | Ameba cyst    | Gm - bacilli   |           |                  |
| Fat content     | < 6 gm/day        |               |                | 10 gm/day | 11 gm/day        |
| - Split fat     | ---               | ---           | ---            | 90 %      | 50 %             |
| - Unsplit fat   | ---               | ---           | ---            | 10 %      | 50 %             |
| Diagnosis       |                   |               |                |           |                  |

| Example number | Answer :                                 |
|----------------|------------------------------------------|
| 1              | Amebic dysentery                         |
| 2              | Bacillary dysentery                      |
| 3              | Mal-absorption (intestinal)              |
| 4              | Mal-digestion (pancreatic hepatobiliary) |



| The CD contains MCQs questions for the clinical pathology : STOOL ANALYSIS MCQS |                       |                     |
|---------------------------------------------------------------------------------|-----------------------|---------------------|
| Stool analysis                                                                  | From question no. 340 | To question no. 343 |



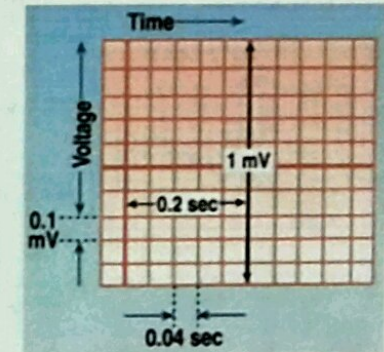
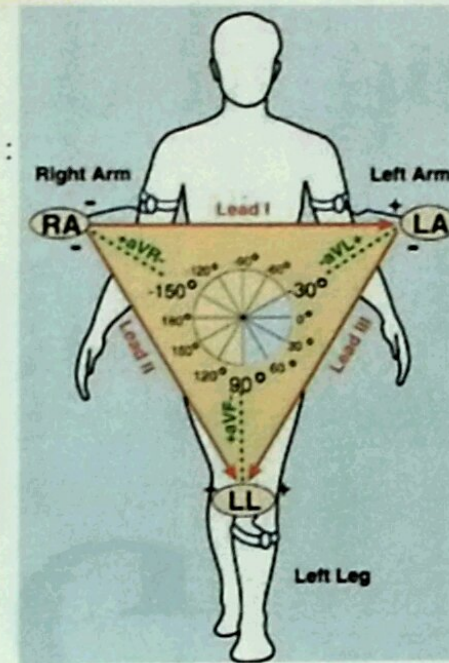
# ECG

الذي يرحون بالدموع يخصصون بالابتهاح  
انظروا إلى الأجيال القديمة وتأملوا. هل توكل أحد على الرب فخزي؟  
الذي بدأ معك أول الطريق له يتركت في منتصفه  
هو شاف هو عارق مش ينسى ☺



## Electrocardiogram:

- **Definition :** ECG is the recording of the heart electric activity
- **Leads :** 12 leads
  - A. 6 limb leads, it gives a potential difference between 2 points :
    - 3 bipolar ( standard ) : LI , LII , LIII
    - 3 unipolar ( augmented ) : avR, avL, avF
  - B. 6 precordial (chest) leads, it gives an isolated point at each :  
V1 , V2 , V3 , V4 , V5 , V6
  - C. Leads are described in Einthoven triangle
  - D. Value of leads in relation to heart :
    - LI , V1→V6 : record anterior surface
    - LII, III , avF : record inferior surface
    - LI, avL, , V5, V6 : record lateral surface

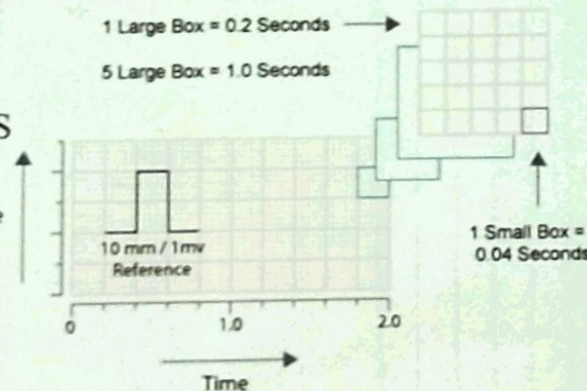


### • Normal ECG :

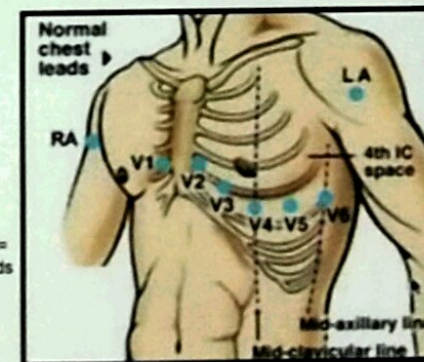
- P wave : atrial depolarization
- QRS complex : ventricular depolarization
- T wave : ventricular repolarization
- NB: repolarization of the atria masked by QRS.

### • Tape :

- 0.04 sec. = 1 **Small Square (SS)**
- 0.2 sec = 1 **Large Square (LS)** = 5 SS
- 1 second = 5 LS = 25 SS
- 1 minute = 300 LS = 1500 SS
- 1mv = 2LS = Standard calibration
- 0.1 mv = SS
- LS = 5 SS



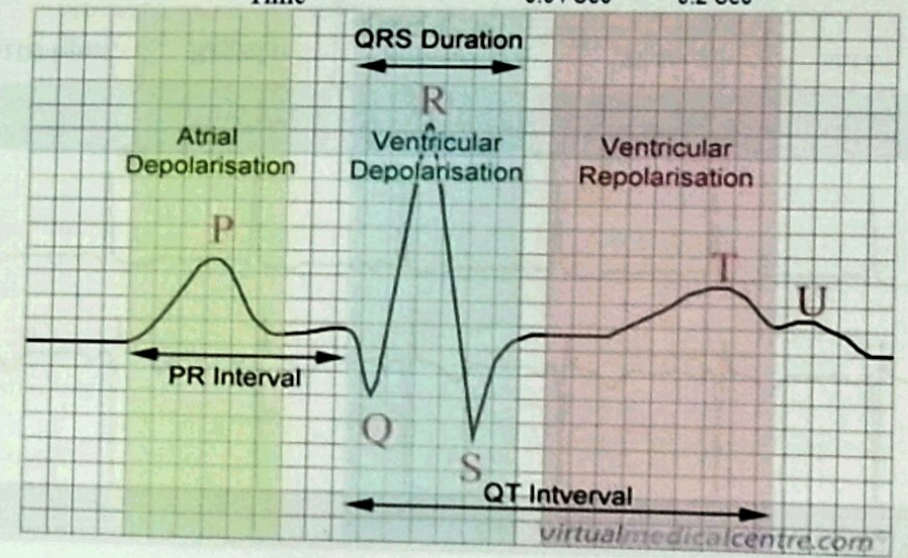
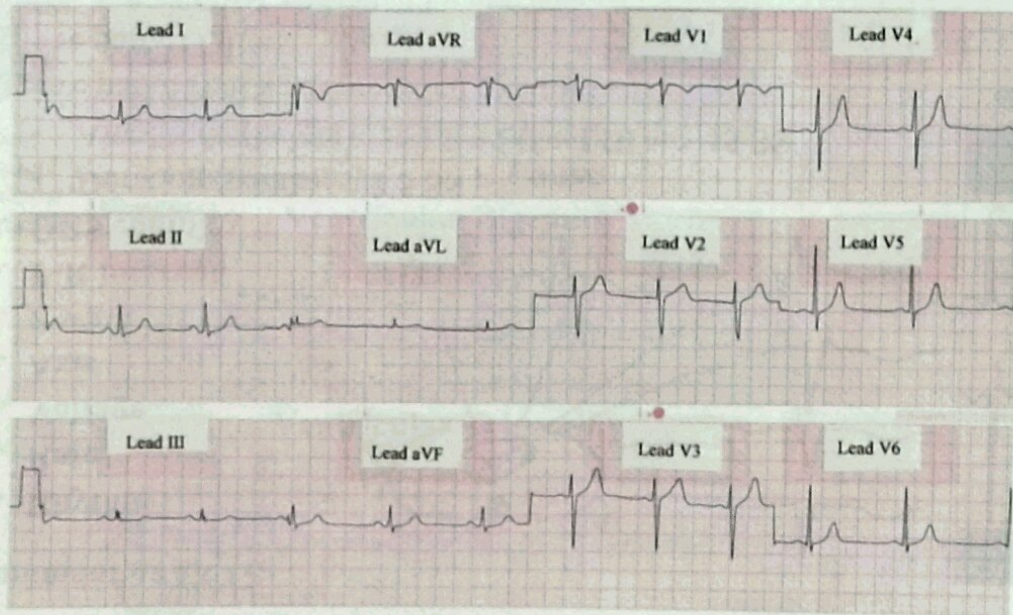
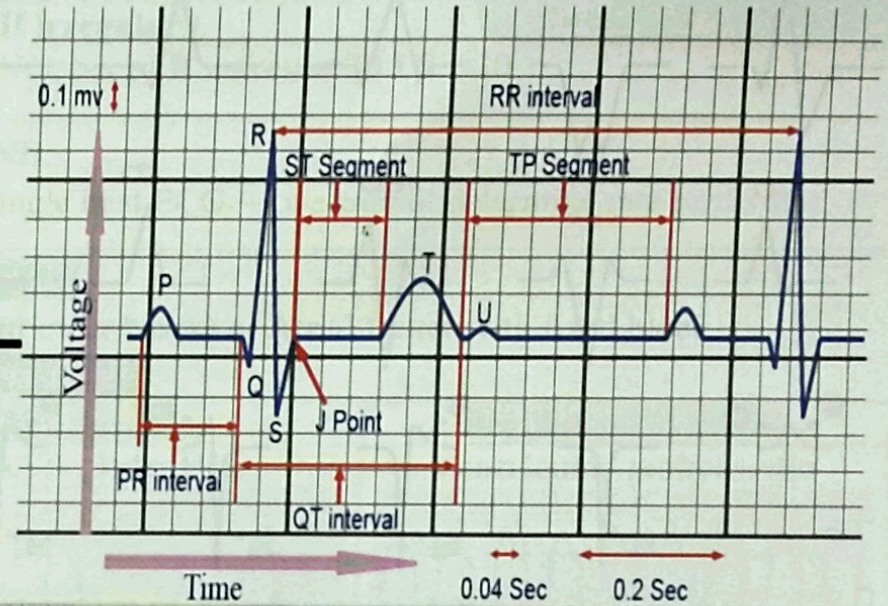
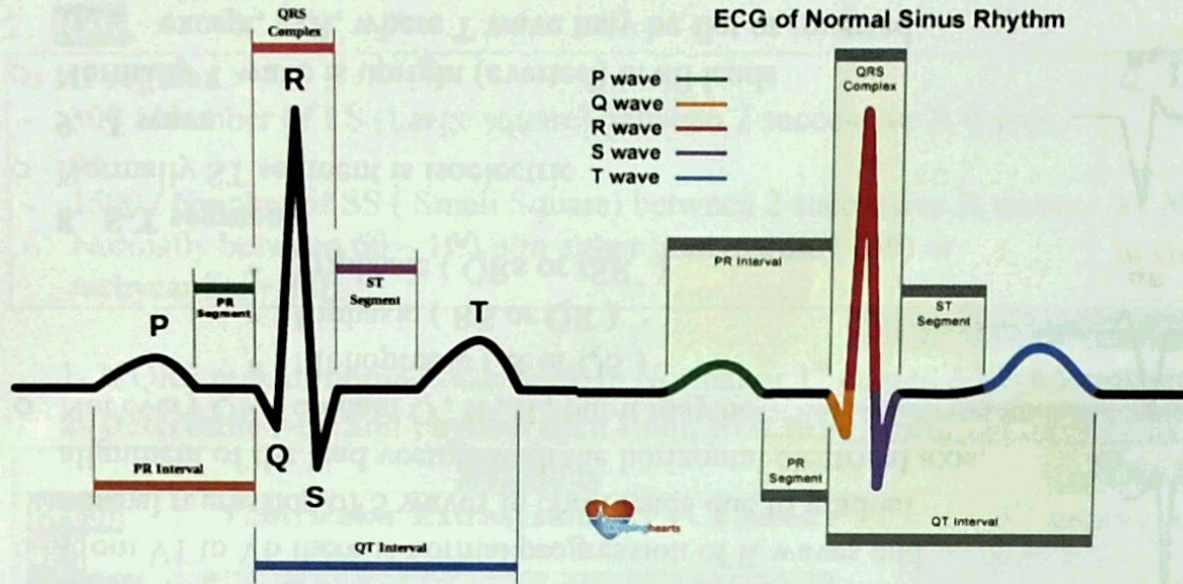
## Precordial or Chest Leads



- |                |                                                |
|----------------|------------------------------------------------|
| V <sub>1</sub> | 4th intercostal (right)                        |
| V <sub>2</sub> | 4th intercostal (left)                         |
| V <sub>3</sub> | Between V <sub>2</sub> & V <sub>4</sub>        |
| V <sub>4</sub> | Midclavicular (mid-collarbone)                 |
| V <sub>5</sub> | 5th intercostal space (anterior axillary line) |
| V <sub>6</sub> | 5th intercostal (midaxillary line)             |



## Normal ECG:





## Comment on ECG:

### 1. Rhythm

### 2. Rate

### 3. Voltage

### 4. Axis

### 5. P wave

### 6. P-R interval

### 7. QRS complex

- Duration (width):  $< 2.5$  SS ,
- Amplitude (height) : in LI + LII + LIII =  $\geq 15$  SS

- **Q:** -ve part of QRS not preceded by any +ve
- **R:** +ve part of QRS
- **S:** -ve part of QRS preceded by any +ve
- From V1 to V6 there is normal progression of R waves and normal regression of S waves in chest leads due to gradual alignment of the lead vectors with the horizontal electrical axis.
- Not every QRS contain Q , R , S , but it may be
  - Monophasic ( R or QS )
  - Biphasic ( RS or QR )
  - Triphasic ( QRs or rSR' )

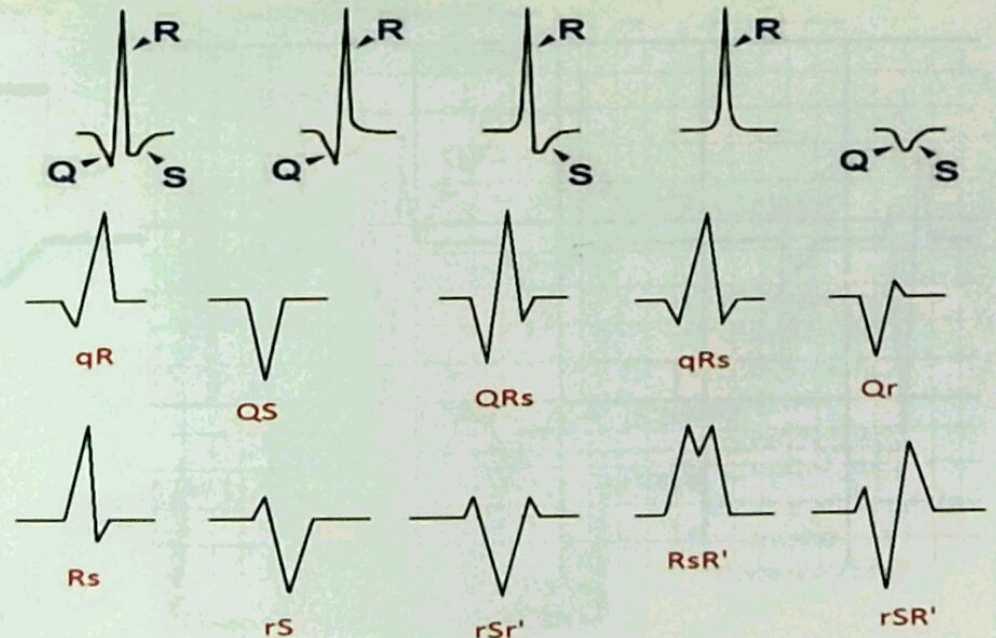
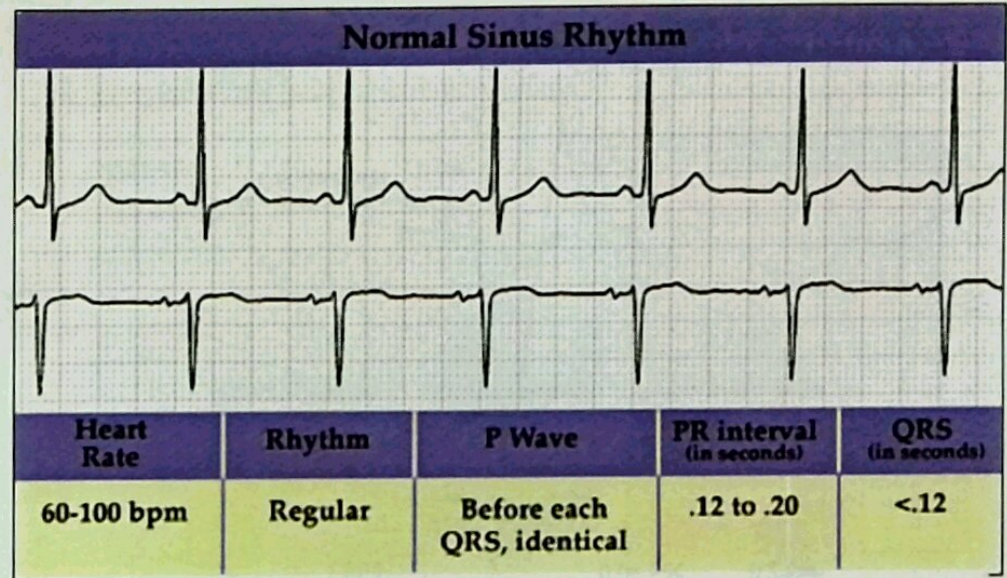
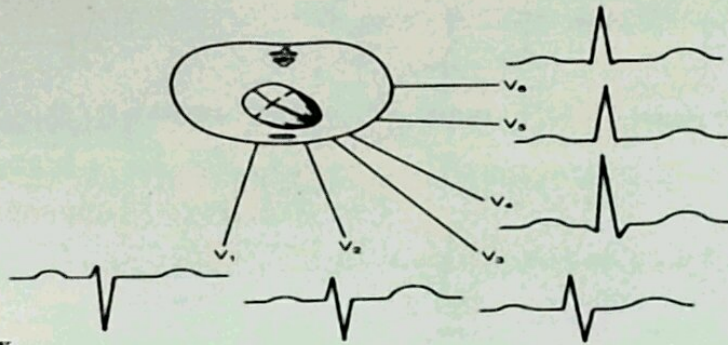
### 8. S-T segment

- Normally ST segment is isoelectric

### 9. T wave

- Normally T wave is upright (everted) in all leads except, avR, where T wave may be flat or inverted

### 10. Diagnosis





## Comment on ECG

1. **Rhythm** : regular or irregular by paper test by measuring the space between two successive QRS (R to R) or (S to S)
2. **Rate**,

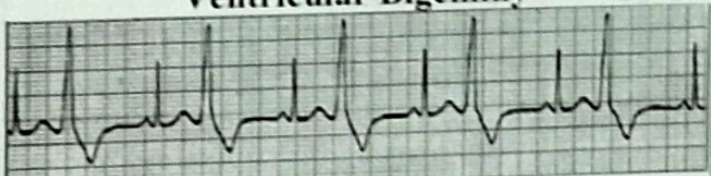
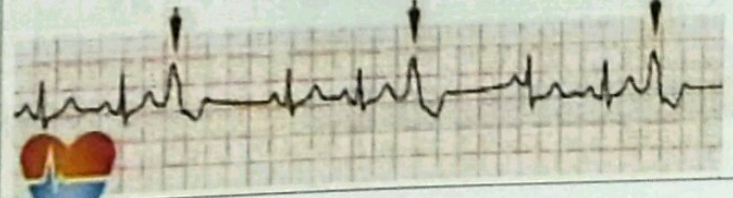
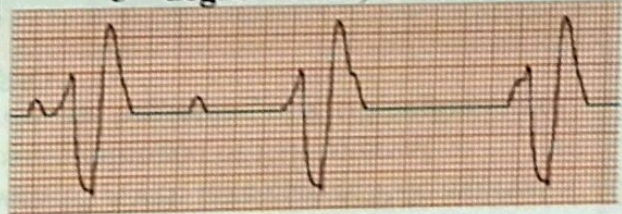
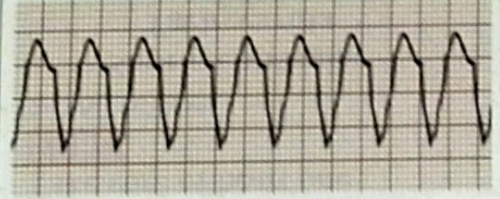


- |                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>○ If regular :                     <ul style="list-style-type: none"> <li>- <math>300 / \text{Number of LS (Large square) between 2 successive R waves}</math> or</li> <li>- <math>1500 / \text{Number of SS ( Small Square) between 2 successive R waves}</math></li> <li>- Normally between 60 – 100 b/m either bradycardia (&lt;60) or tachycardia(&gt;100).</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>○ If irregular :                     <ul style="list-style-type: none"> <li>- Number of R waves in 30 LS x 10</li> </ul> </li> <li>➤ NB:<br/>In single beat ECG → we cannot determine rate or rhythm.</li> </ul> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### ✓ Rhythm strip scheme :

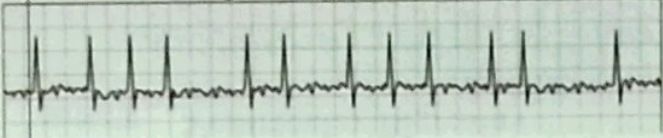
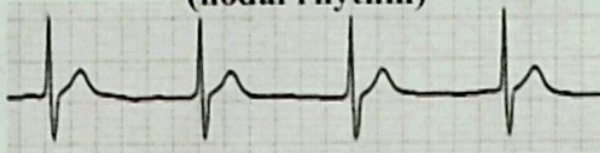
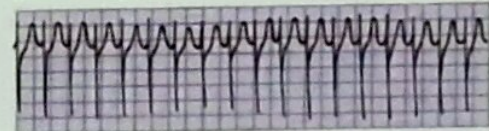
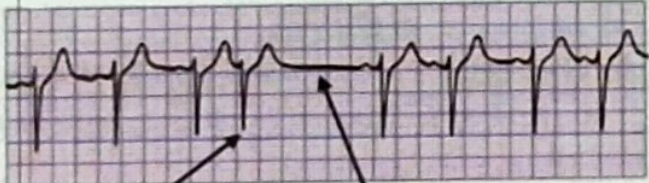
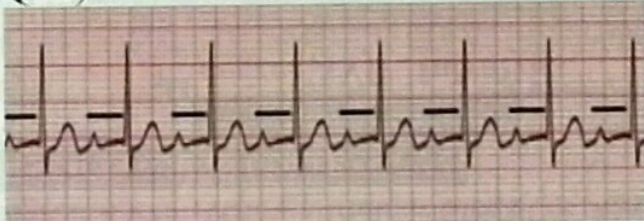
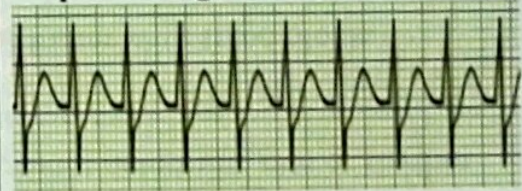
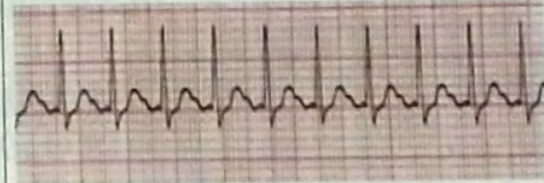
1- If QRS regular normal rate: think in Normal or 1<sup>st</sup> degree AVB (Atrioventricular block) or Atrial flutter with fixed block.

2- Determine rate and rhythm then Look first to **QRS: if broad & bizarre (wide)**

|                                                                                          | Irregular                                                                                                                                                                                                                                                                                                                                                                                                                   | Regular bradycardia                                                                                                                | Regular tachycardia                                                                                                   |
|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Broad and Bizarre QRS (Wide)</b><br>NB :<br>PVCs = premature ventricular contractions | <b>Ventricular Extrasystole = PVCs (normal P wave)</b><br><br><b>Extrasystole</b> <b>Pause</b><br><b>Ventricular Bigeminy</b><br><br><b>Ventricular Trigeminy</b><br> | <b>3<sup>rd</sup> degree AVB , InfraHiss</b><br> | <b>Ventricular tachycardia</b><br> |



### 3-If QRS Narrow Normal → check P wave ; could be absent or single or multiple :

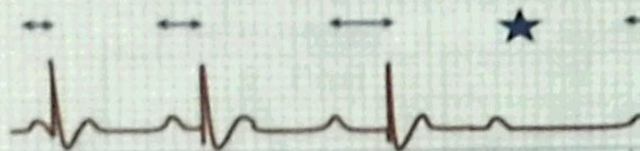
|                      | Irregular                                                                                                                                                                                                                                                                                                                                                                                                             | Regular bradycardia                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Regular tachycardia                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Absent P wave</b> | <p>AF = Atrial fibrillation على السطر<br/>P wave absent , replaced by f wave<br/>which may be : coarse , fine , absent</p>                                                                                                                                                                                                           | <p>Mid Junctional rhythm<br/>(nodal rhythm)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>Supraventricular tachycardia<br/>(nodal ; absent P wave)<br/>Junctional (nodal) tachycardia</p>                                                                                                                                                                                                                                            |
| <b>Single P wave</b> | <p>❖ There is a space , return back to see the relationship between last two beats (QRS)<br/><b>Either :</b><br/>➤ Crowded :<br/>Supraventricular Extrasystole , there is compensatory pause</p>  <p><b>Or</b><br/>➤ Normal :<br/>- <b>Variable 2<sup>nd</sup> AVB</b> , check P-R interval either : Mobitz type I OR Mobitz II</p> | <p><b>Sinus bradycardia</b> , usually associated with 1<sup>st</sup> AVB; take care of P-R interval : Fixed prolonged of P-R interval (from the beginning of P till beginning of QRS)</p>  <p>NB: <u>supraventricular extrasystole could be either:</u></p> <ul style="list-style-type: none"> <li>- Nodal = premature nodal contractions (PNCs) → inverted or absent P or</li> <li>- Atrial= premature atrial contractions (PACs) → abnormal (deformed) P wave : <ul style="list-style-type: none"> <li>➤ Atrial extrasystole</li> <li>➤ Atrial Bigeminy</li> <li>➤ Atrial Trigeminy</li> </ul> </li> </ul> | <p>➤ Take care of heart rate :<br/><b>Either</b><br/>➤ &gt; 160 b/m =<br/><b>Supraventricular Tachycardia</b><br/>- Atrial : the P wave are superimposed on the preceding T wave.</p>  <p>➤ <b>Or</b> 100 → 160 b/m =<br/><b>sinus tachycardia</b></p>  |



- **Mobitz type I:**

- Progressive prolongation of PR interval till dropped of QRS (Wenckbach)

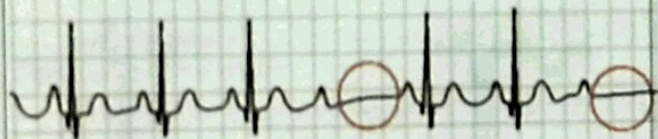
MOBITZ TYPE 1



Or

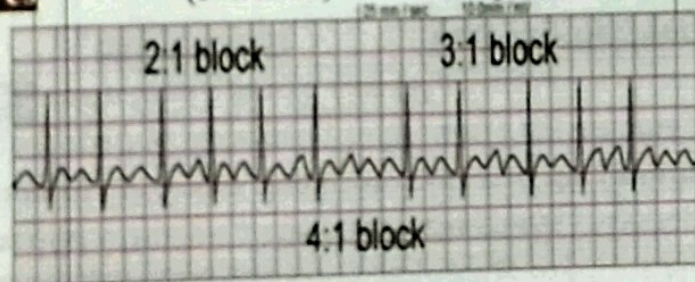
- **Mobitz II:**

Dropped QRS without lengthening of PR interval (Constant).



**Multiple P waves**

Atrial flutter with variable block (F waves) saw teeth pattern

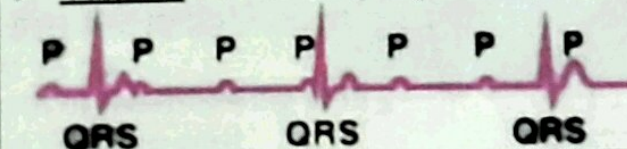


❖ Check the number and site of P between each 2 QRS :

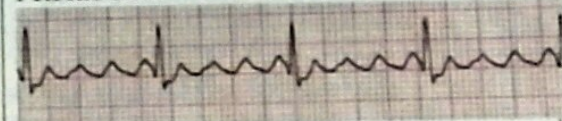
**Either**

➤ **Fixed** : 2<sup>nd</sup> AVB , fixed block : 3 : 1 **or**

➤ **Variable** : 3<sup>rd</sup> AVB ( SupraHiss)



Atrial flutter with fixed block ,  
4: 1 = saw teeth pattern  
Atrial rate = No of P x HR

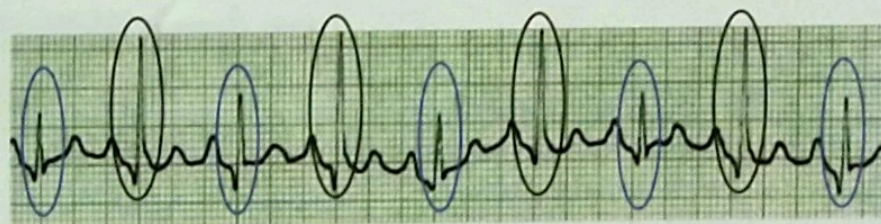




✓ **Complete ECG scheme** : = rhythm strip scheme (from the completed lead) + the following :

### 3. Voltage:

- Normal voltage : QRS amplitude in LI + LII + LIII =  $\geq 15$  SS
- ❖ **Causes of low voltage** : QRS amplitude in LI + LII + LIII =  $< 15$  SS
  - Pericardial effusion : **electrical alternans** may occur due to beat to beat alteration of QRS axis due to swinging of the floating heart in the effusion
  - Cardiomyopathy, ischemia, infarction, myxedema, emphysema



### 4. Axis : from lead I & avF ( or III )

|                 | Normal axis | Left axis deviation<br>أهل الشمال : متخاصمين                                                                                                                                                           | Right axis deviation<br>أهل اليمين : يسلموا على بعض                                                                                                                                                                       | Extreme axis deviation<br>= No man's land لا بتاعك ولا بتاعه |
|-----------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| Lead I          | +ve QRS<br> | +ve QRS<br>                                                                                                                                                                                            | -ve QRS<br>                                                                                                                                                                                                               | -ve QRS<br>                                                  |
| Lead III or avF | +ve QRS<br> | -ve QRS<br>                                                                                                                                                                                            | +ve QRS<br>                                                                                                                                                                                                               | -ve QRS<br>                                                  |
| Causes          |             | <ul style="list-style-type: none"> <li>○ LVH</li> <li>○ LBBB</li> <li>○ Left anterior hemiblock</li> <li>○ Ascites</li> <li>○ Hyperkalemia</li> <li>○ Inferior infarction</li> <li>○ Normal</li> </ul> | <ul style="list-style-type: none"> <li>○ RVH</li> <li>○ RBBB</li> <li>○ Left posterior hemiblock</li> <li>○ Chronic lung disease</li> <li>○ Pulmonary embolism</li> <li>○ Lateral infarction</li> <li>○ Normal</li> </ul> | Causes of RAD + LAD except normal.                           |

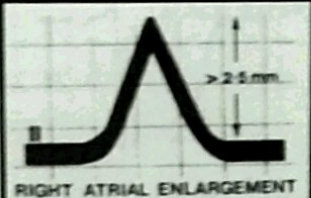
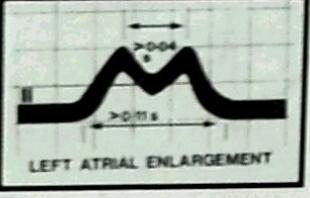
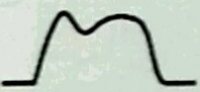


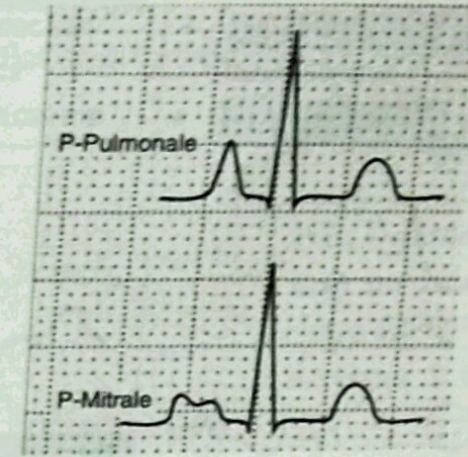
## 5. Lead II :

1- شكل  
Atrial  
+++

### ❖ P wave :

- Normal = 2.5 x 2.5 SS
- Represent atrial depolarization ; sinus rhythm
- Abnormally :

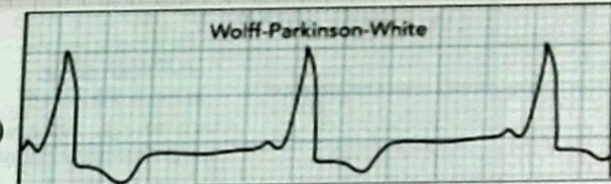
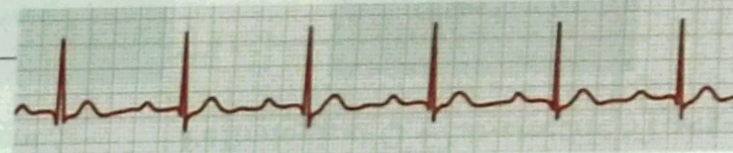
| Tall & Peaked<br>P pulmonale                                                      | Broad & Bifid<br>P mitrale                                                         | P- Pulmonale-<br>mitrale                                                            |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |
| RIGHT ATRIAL ENLARGEMENT                                                          | LEFT ATRIAL ENLARGEMENT                                                            |                                                                                     |
| RA +                                                                              | LA +                                                                               | Biatrial +                                                                          |
| <u>Causes :</u><br>TR, TS, RVF                                                    | <u>Causes :</u><br>MS, MR, LVF                                                     |                                                                                     |



2- كطول  
1<sup>st</sup> AVB

### ❖ P-R interval :

- From the beginning of P till beginning of QRS
- Normal : 3 – 5 SS
- Abnormally :
- Fixed prolonged (>5SS) of PR interval : 1<sup>st</sup> AVB
- Short (<3SS) PR interval & wide QRS & Delta wave ( initial slowing of QRS ) = Wolff Parkinson White Syndrome



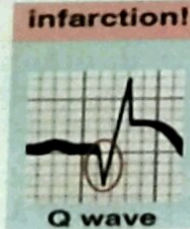
3- يا إما  
كجلطة

### ❖ Normal Q wave :

- less than 1 SS in width , less than 2 SS in height (amplitude) or < 25 % of depth of the following R in ↓
- Normally in lead I & avL , **V5 , V6**

### ❖ Abnormally : Pathological Q = infarction : تعرفنا ان فيه جلطة

- In any site rather than normal
- > 1 SS in ↔ , > 2 SS in ↓ , > 25 % of depth of the following R in ↓
- Present in at least two successive leads in the same wall



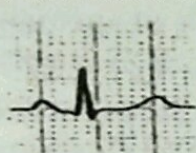
### • DD of pathological Q:

- Myocardial infarction
- Myocarditis
- Hypertrophic cardiomyopathy
- Infiltrative muscle disease
- LBBB

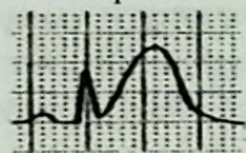


## الزمان عن طريق J point

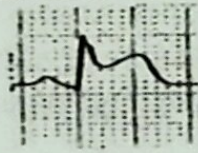
- **ST segment and T wave ; normal ST segment is isoelectric (with absence of pathological Q)& T wave is upright :**  
Look for J point :
- **J point :** The point at which the QRS complex finishes and the ST segment begins, it is used to measure the degree of ST elevation or depression present in relation to the baseline of ECG which is PR segment.



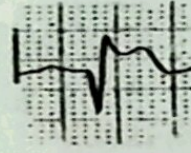
**Normal**



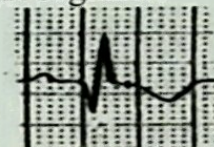
**Hyperacute T-Wave**  
minutes-hours



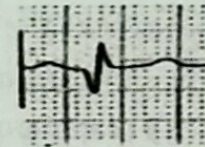
**ST-elevation**  
0-12 hours



**Q-wave developing**  
over  
1-12 hours

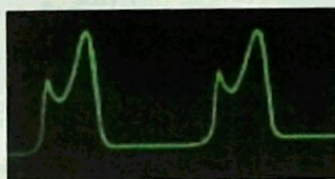


**ST-elevation**  
With T-wave  
Inversion  
2-5 days



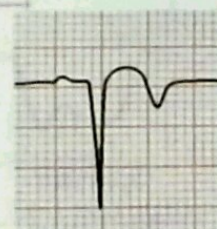
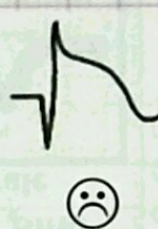
**T-wave recovery**  
weeks-months

**Recent Hyperacute MI**  
NO Pathological Q + ST segment ↑



- **NO** pathological Q or poor R progression
- **ST segment elevation**
- **± Hyperacute T wave** (tall(>2LS), narrow, symmetrical & peaked)

**Recent acute MI**  
Pathological Q + ST segment ↑

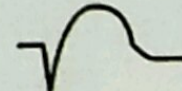


- **Pathological Q** or poor R progression
- **ST segment : elevation** (Convex upwards) then descending to baseline
- **T wave : biphasic then symmetrically inverted**

**Chronic (Old) MI**  
Pathological Q + iso-electric ST seg.



Aneurysm



- **Pathological Q** or poor R progression
- **ST segment & T wave : normal** or elevated if old MI with aneurysm



المكان عن طريق البحث عن نفس التغيرات عند إخوانه :

• **Topography of myocardial infarction :**

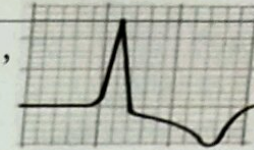
- Lead : II, III, avF = inferior myocardial infarction

يا إما  
كإسكيما

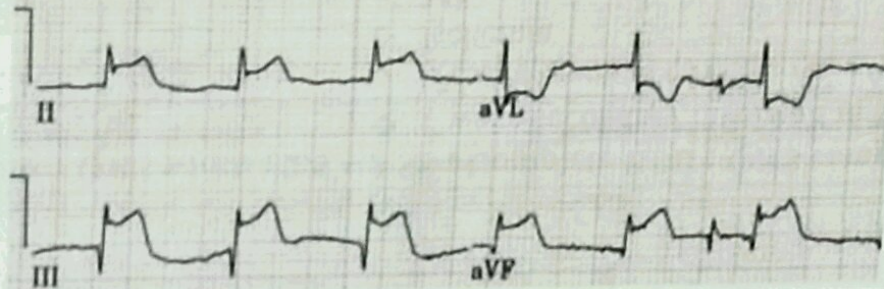
• **Ischemia** = ST segment depression with depressed J point and T wave flat or inverted ,

• **Topography of ischemia :**

- Lead : II, III, avF = inferior myocardial ischemia



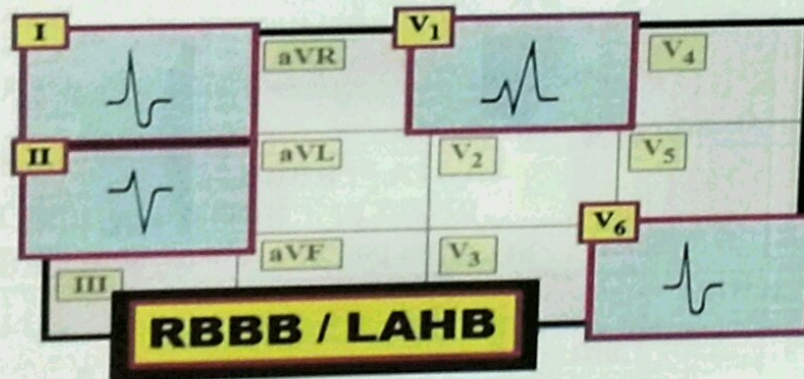
Recent acute inferior  
myocardial infarction



**NB: Double infarction**  
may be present in the  
same ECG, one of them  
is recent & the other is  
old.

○ **Hemiblock = Fascicular block**

-4- كبلوك



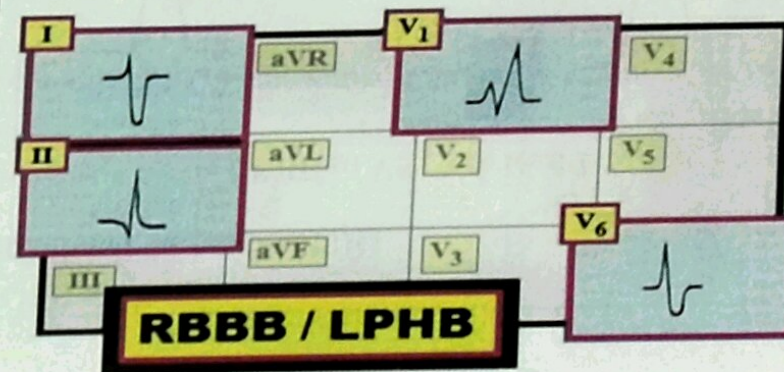
**Left anterior hemiblock**

• LAD + Deep S wave ( R/S ratio < 1 ) in II , III , avF

➤ **NB :**

• Bifascicular block = RBBB + Hemiblock

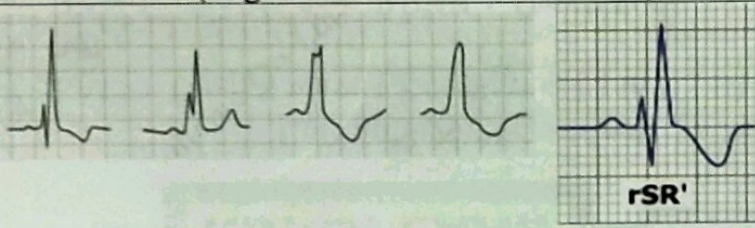
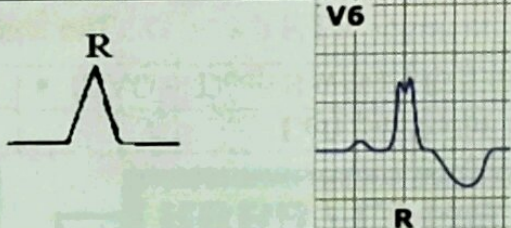
• Trifascicular block = RBBB + Hemiblock + 1<sup>st</sup> degree AVB



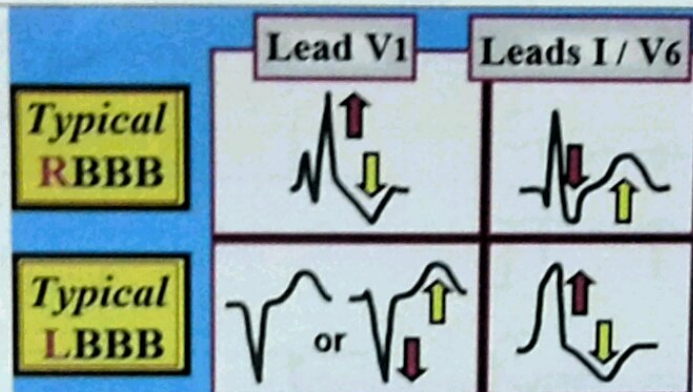
**Left posterior hemiblock**

• RAD + Deep S wave ( R/S ratio < 1 ) in I & avL



| 6-                             | V1                                                                                                                                                                                                                                                                                                                                                        | V6                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1- يا إما<br>كشكل<br>BBB       | <b>RBBB</b><br><b>(Right Bundle Branch Block)</b><br>                                                                                                                                                                                                                    | <b>LBBB</b><br><b>(Left Bundle Branch Block)</b><br>                                                                                                                                                                                              |
|                                | <b>QRS</b><br><ul style="list-style-type: none"> <li>• <u>RR'</u>; monophasic notched tall R OR</li> <li>• <u>rSR'</u> ( with wide R' ); M shaped<br/>= RBBB in V1 , V2</li> </ul> <p>○ للتأكد هتلاقى عند :<br/>V5 &amp; V6 , lead I → qRs ( with large slurred s )</p>  | <p>❖ BBB = Wide QRS &gt; 2.5 SS</p> <ul style="list-style-type: none"> <li>○ <u>Monophasic (± notched) (R)</u><br/>= LBBB in V5 , V6, lead I</li> </ul> <p>○ للتأكد هتلاقى عند :<br/>V1 &amp; V2 → QS (the entire complex is negative) or rS</p>  |
|                                | ○ Incomplete BBB : QRS width : 2.5 – 3 SS , Complete BBB : QRS complex width > 3 SS                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                      |
| <b>T wave</b><br><b>Causes</b> | <ul style="list-style-type: none"> <li>❖ T wave secondary inversion in V1,V2</li> <li>○ RV enlargement (ASD , PS , PH , P.embolism)</li> <li>○ Ischemia</li> <li>○ Inferior MI</li> <li>○ Degeneration by age</li> <li>○ RT sided catheter</li> <li>○ Rate dependent</li> <li>○ Normal</li> </ul>                                                         |                                                                                                                                                                                                                                                                                                                                      |
|                                | <ul style="list-style-type: none"> <li>❖ T wave secondary inversion in V5,V6</li> <li>○ LV enlargement ( HTN , AS , AR )</li> <li>○ Ischemia</li> <li>○ MI</li> <li>○ Calcification of mitral annulus</li> <li>○ Cardiomyopathy</li> <li>○ Rate dependent</li> <li>○ Normal</li> </ul>                                                                    |                                                                                                                                                                                                                                                                                                                                      |





NB:

إذا لم تحقق شكل ال BBB :

لا تكمل رحلة البحث عن الطول وعن الجلطة أو إسكيميا

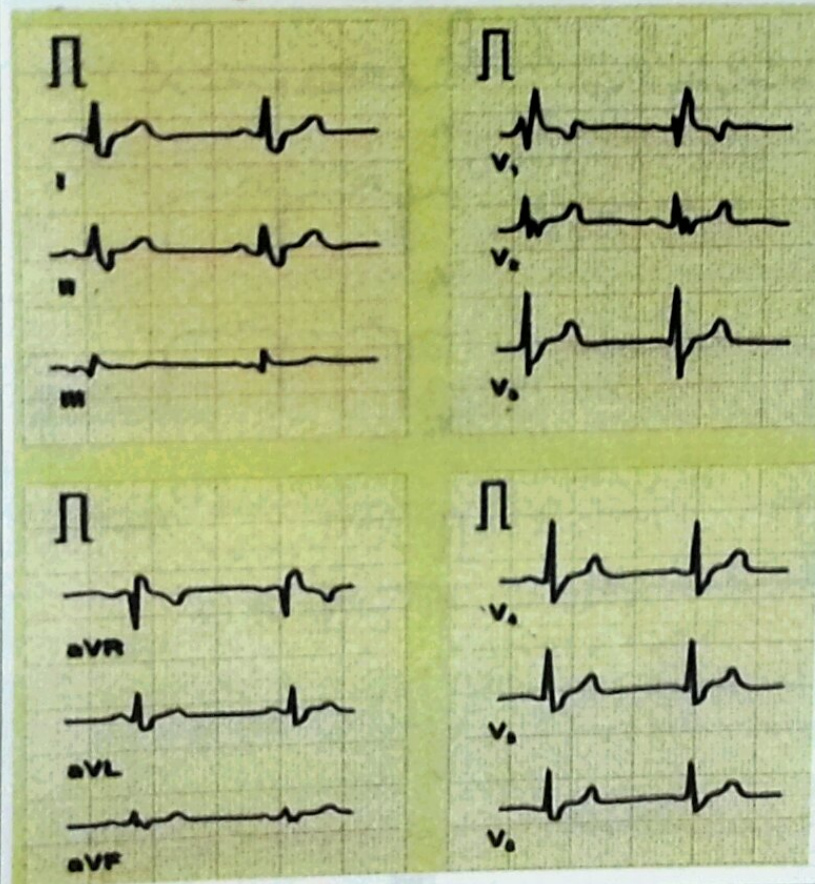
○ In RBBB , don't diagnose :

- Myocardial ischemia
- Ventricular enlargement

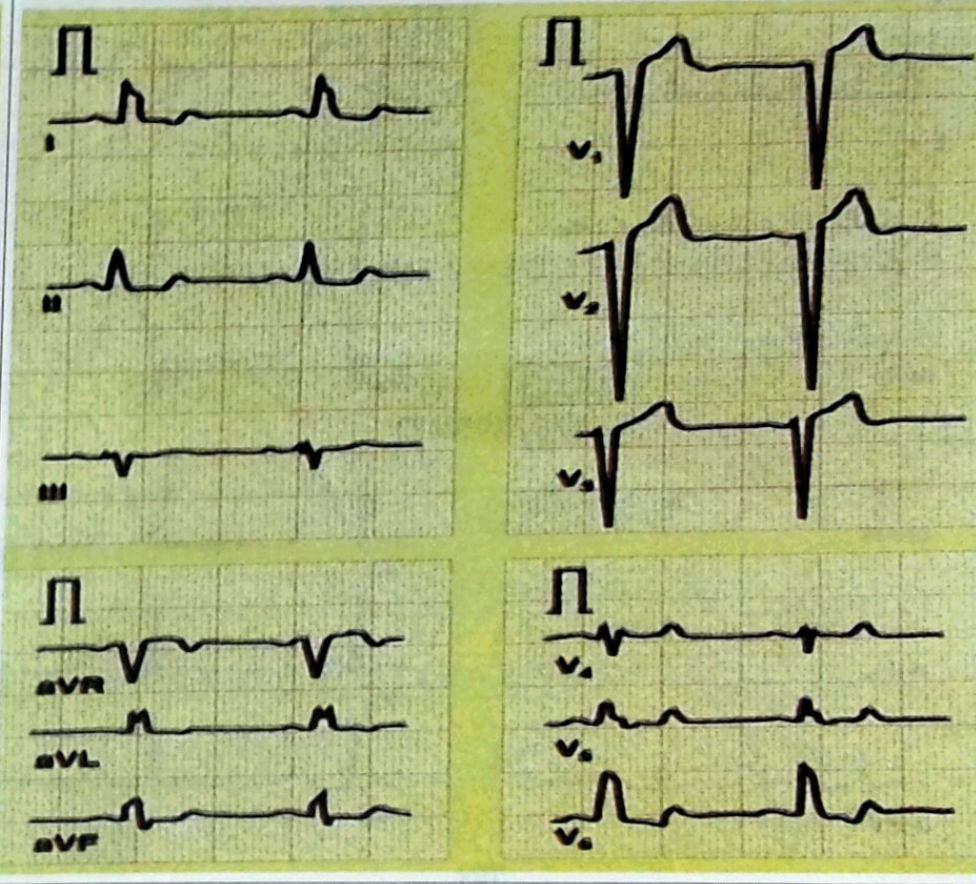
○ In LBBB , don't diagnose :

- Myocardial ischemia
- Myocardial infarction
- Ventricular enlargement
- Hemiblock

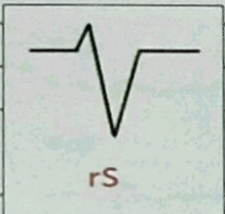
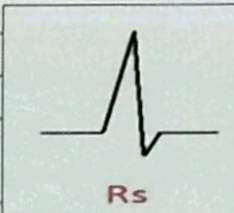
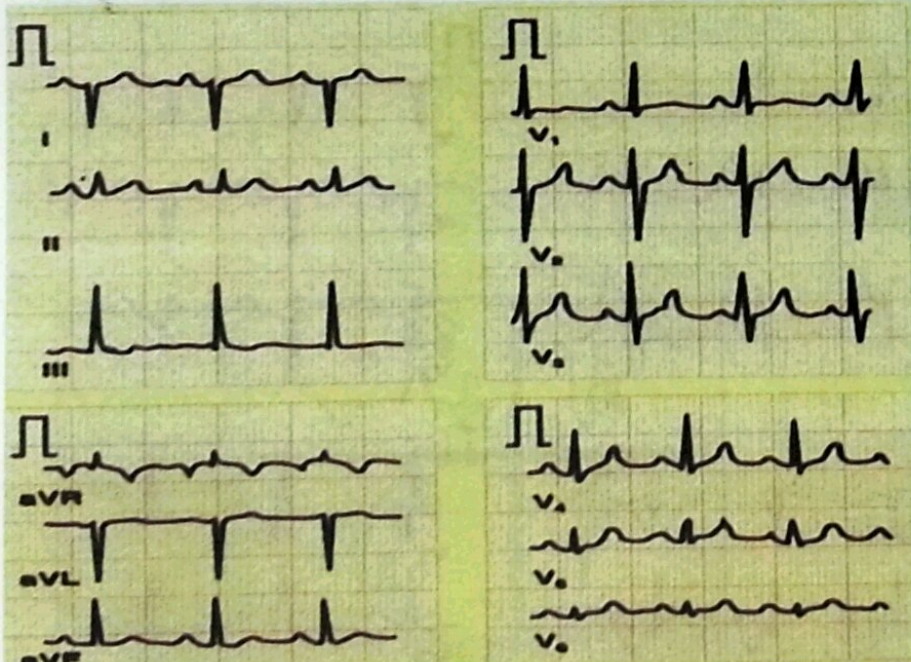
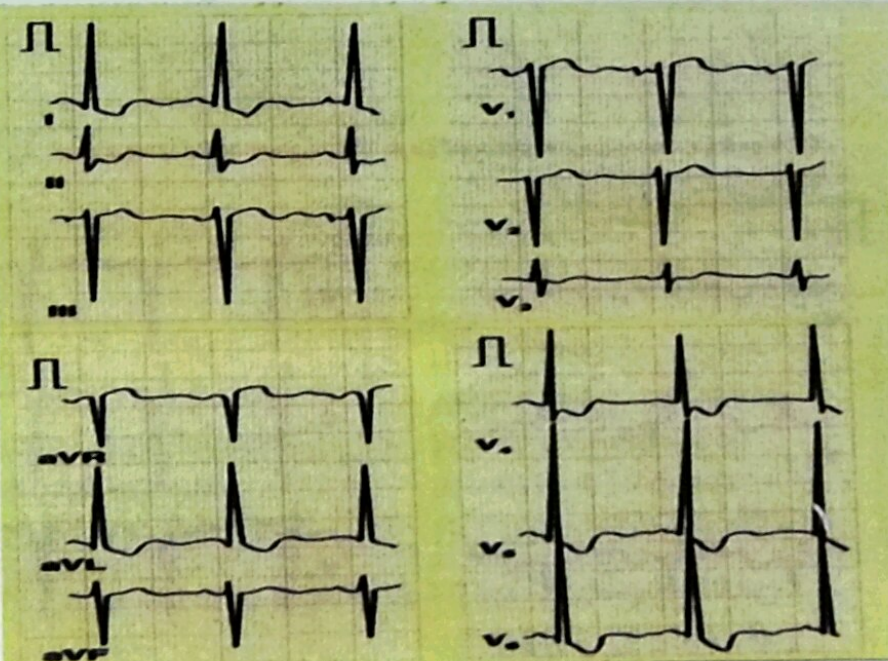
### Right bundle branch block



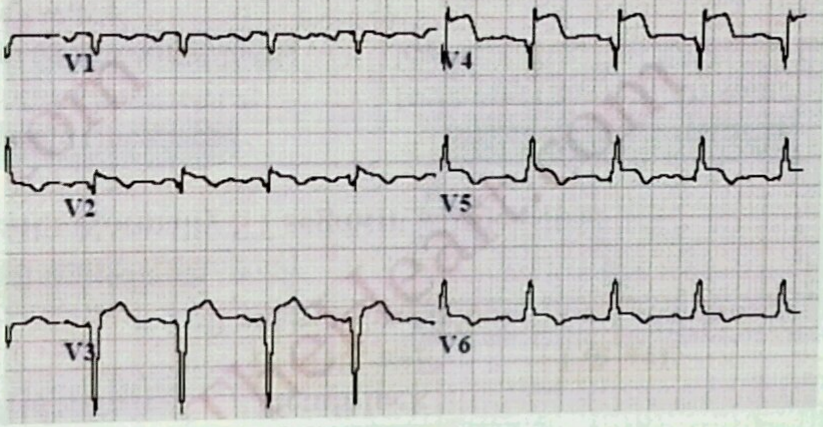
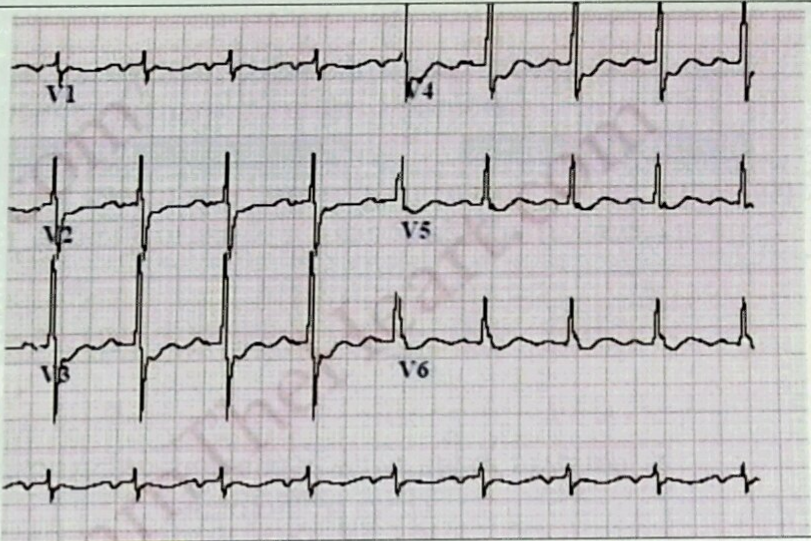
### Left bundle branch block





|                                                                                     |                                                                                  |                                                                                      |                                                                                    |  |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|--|
| يا إما<br>كطول<br>VH                                                                | <b>V1</b>                                                                        |                                                                                      | <b>V6</b>                                                                          |  |
|                                                                                     |  |                                                                                      |  |  |
|                                                                                     | rS                                                                               |                                                                                      | Rs                                                                                 |  |
|                                                                                     | ❖ <b>QRS</b>                                                                     |                                                                                      |                                                                                    |  |
|                                                                                     | ❖ <b>Normal</b>                                                                  |                                                                                      |                                                                                    |  |
|                                                                                     | rS                                                                               |                                                                                      | Rs                                                                                 |  |
|                                                                                     | ❖ <b>Abnormally :EITHER : Exaggerated &gt; 5 LS بالبلدي ( LS = 5 mm )</b>        |                                                                                      |                                                                                    |  |
|                                                                                     | S in V1, V2 > 25 mm                                                              |                                                                                      | R in V5, V6 > 25 mm                                                                |  |
|                                                                                     | Left Ventricular Hypertrophy                                                     |                                                                                      | Left Ventricular Hypertrophy                                                       |  |
|                                                                                     | <b>OR</b> بالبلدي <b>Inverted</b>                                                |                                                                                      |                                                                                    |  |
| Dominant R= R/S ratio in V1 ≥ 1                                                     |                                                                                  | Deep S = R/S ratio in V6 < 1                                                         |                                                                                    |  |
| Right Ventricular Hypertrophy (VH)                                                  |                                                                                  | Right Ventricular Hypertrophy (VH)                                                   |                                                                                    |  |
| ❖ Strain pattern :                                                                  |                                                                                  | ❖ Strain pattern :                                                                   |                                                                                    |  |
| ST segment depression ± T wave inversion in V1 , V2                                 |                                                                                  | ST segment depression ± T wave inversion in V5 , V6                                  |                                                                                    |  |
| NB : biventricular hypertrophy (enlargement ) :                                     |                                                                                  |                                                                                      |                                                                                    |  |
| - Signs of LVE + tall R in V1 Or Signs of LVE + RAD                                 |                                                                                  |                                                                                      |                                                                                    |  |
| <b>Right ventricular hypertrophy</b>                                                |                                                                                  | <b>Left ventricular hypertrophy</b>                                                  |                                                                                    |  |
|  |                                                                                  |  |                                                                                    |  |



|                     | V1                                                                                                                                                                                             | V6 هنا لازم تطبق الشروط                                                                                                                                                                                                              |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2- يا إما<br>كجلاطة | Infarction; Same principles as in Lead II but the topography is different :                                                                                                                    |                                                                                                                                                                                                                                      |
|                     | <ul style="list-style-type: none"> <li>V1 – V2 = septal</li> <li>V3 – V4 = anterior</li> <li>V1 → V3 (<math>\pm</math>V4) = anteroseptal</li> </ul>                                            | <ul style="list-style-type: none"> <li>Lateral: V5-V6, I , avL =</li> <li>- High lateral : I , avL</li> <li>- Low lateral : V5 , V6</li> <li>V3→V6, I , avL = antero-lateral</li> <li>V1→V6, I , avL = extensive anterior</li> </ul> |
| يا إما<br>كإسكيميا  | <ul style="list-style-type: none"> <li><b>Ischemia</b> = ST segment depression with depressed J point and T wave flat or inverted</li> <li><b>Topography of ischemia</b> : as above</li> </ul> |                                                                                                                                                                                                                                      |
|                     | <b>Recent anterolateral MI</b><br>                                                                          | <b>Antero-lateral ischemia</b><br>                                                                                                               |

### ECG Leads & walls of the myocardium

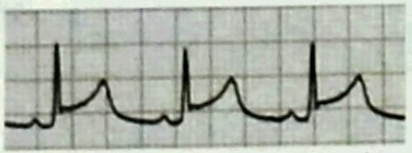
|                                     |              |     |              |    |                 |    |                 |
|-------------------------------------|--------------|-----|--------------|----|-----------------|----|-----------------|
| ECG Leads & walls of the myocardium |              |     |              |    |                 |    |                 |
| I                                   | High lateral | avR |              | V1 | Septal          | V4 | Strict anterior |
| II                                  | Inferior     | avL | High lateral | V2 | Septal          | V5 | Low lateral     |
| III                                 | Inferior     | avF | Inferior     | V3 | Strict anterior | V6 | Low lateral     |



### Revision of ECG scheme:

|                     | 1- Rhythm                                         | 2. Rate | 3- Voltage               | 4- Axis                                                                                         |
|---------------------|---------------------------------------------------|---------|--------------------------|-------------------------------------------------------------------------------------------------|
|                     | 5- Lead II                                        |         |                          |                                                                                                 |
| 1- كشكـل            | P wave                                            |         |                          |                                                                                                 |
| 2- كـطـول           | P-R interval                                      |         |                          |                                                                                                 |
| 3- يا إما كـجـلـطـة | Pathological Q                                    |         |                          |                                                                                                 |
| يا إما كـبـسـكـيـما | ST segment depression and T wave flat or inverted |         |                          |                                                                                                 |
| 4- كـبـلـوك         | Hemiblock                                         |         |                          |                                                                                                 |
|                     | II , III , avF                                    |         | I & avL                  |                                                                                                 |
|                     | Left anterior hemiblock                           |         | Left posterior hemiblock |                                                                                                 |
|                     |                                                   |         | 6- V1                    | 7- V6                                                                                           |
|                     |                                                   |         | 1- يا إما كـشـكـل        | BBB                                                                                             |
|                     |                                                   |         |                          | لو تـحـقـق شـكـل ال BBB لا تـكـمـل رـحـلـة البـحـث عـن الطـول و عـن الجـلـطـة أو الإـسـكـيـمـيا |
|                     |                                                   |         | يا إما كـطـول            | Ventricular hypertrophy                                                                         |
|                     |                                                   |         | 2- يا إما كـجـلـطـة      | Pathological Q                                                                                  |
|                     |                                                   |         | يا إما كـبـسـكـيـما      | ST segment depression and T wave flat or inverted                                               |

### Differential diagnosis of:

|                                                                                                             |                                           |                                                                                                                      |                          |
|-------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------|
| ○ <b>ST segment</b> : Normally ST segment is isoelectric                                                    |                                           | ○ <b>T wave</b> : Normally T wave is upright (everted) in all leads except avR, where T wave may be flat or inverted |                          |
| <b>Raised ST segment</b>                                                                                    | <b>Depressed ST segment</b>               | <b>Flat or inverted T wave</b>                                                                                       | <b>Hyperacute T wave</b> |
| Myocardial infarction<br>Convex upwards , in some leads ,<br>pathological Q wave<br>Elevated cardiac enzyme | Ischemia (angina), In some leads          | Ischemia (angina) , In some leads                                                                                    | Ischemia                 |
| Pericarditis 😊<br>       | Hypokalemia in all leads                  | Hypokalemia in all leads                                                                                             | hyperkalemia             |
| Concave upwards , in all leads<br>Absent pathological Q wave                                                |                                           |                                                                                                                      |                          |
| Prinzmetal angina<br>flat , in all leads<br>Absent pathological Q wave                                      | Strain pattern of ventricular hypertrophy | Strain pattern of ventricular hypertrophy                                                                            | Acute MI                 |
| Old MI + aneurysm                                                                                           | Sagging depression of digitalis           | BBB                                                                                                                  | Normal variants          |



## ⊗ Miscellaneous :

### ❖ Other Advanced ECG:

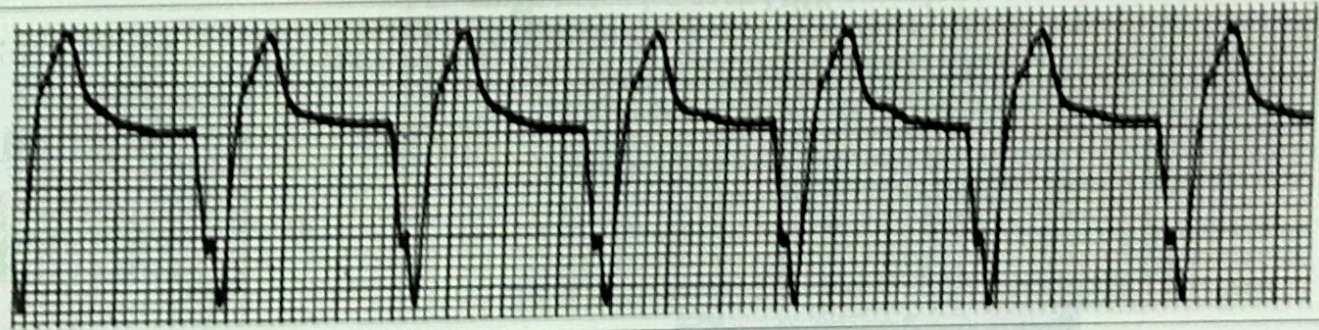
- **Wandering atrial pacemaker** in cases of Sick sinus syndrome
  - $\geq 3$  different P waves
  - Irregular rhythm
  - *Normal rate*



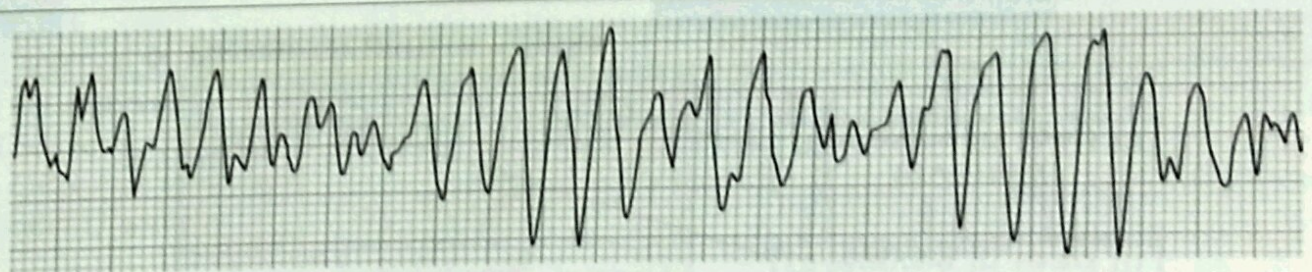
- **Multifocal atrial tachycardia** in cases of chronic hypoxia e.g. COPD
  - $\geq 3$  different P waves
  - Irregular rhythm
  - *Tachycardia*



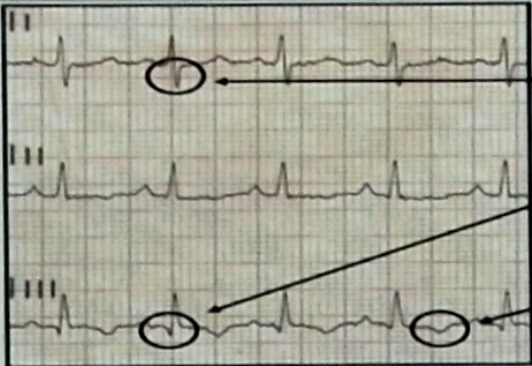
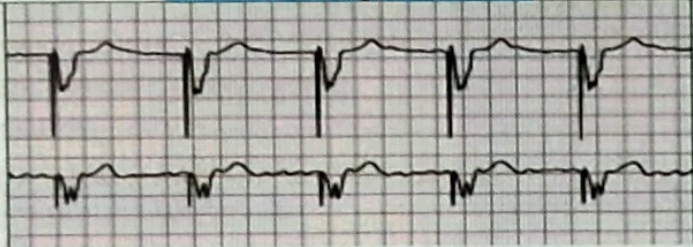
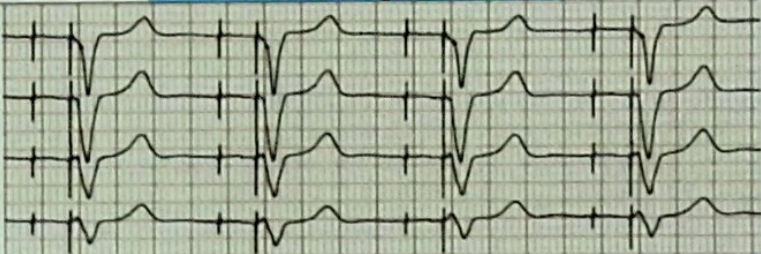
- **Accelerated idioventricular rhythm** is the commonest reperfusion arrhythmia .
  - Rate 40 – 100 b/m
  - Regular rhythm
  - P wave : absent or not related
  - PR interval : none
  - QRS : wide



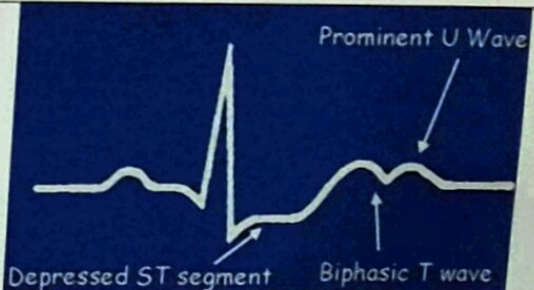
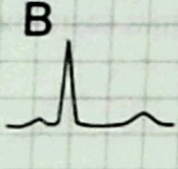
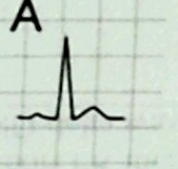
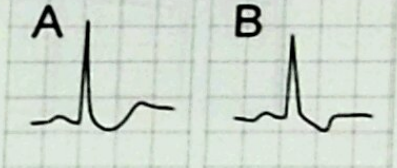
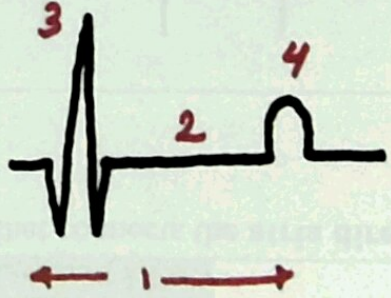
- **Torsades de pointes**
  - Polymorphic ventricular tachycardia
  - Wide QRS complexes.
  - Preceded by long and short RR-intervals
  - Long QT interval from the beginning of Q wave to the end of T wave





|                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li><b>Pulmonary Embolism</b></li> <li>- Sinus Tachycardia</li> <li>- RAD</li> <li>- RBBB</li> <li>- S1, QIII, TIII :             <ul style="list-style-type: none"> <li>▪ Deep S in Lead I,</li> <li>▪ Pathological Q &amp; Inverted T in Lead III</li> </ul> </li> </ul> |  <p>S-waves in lead I</p> <p>Q-waves in lead III</p> <p>Inverted T-waves in lead III</p>                                                                                                                                                                      |
| ❖ <b>Pacemaker pattern = Spike</b>                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                |
| <p><b>Ventricular pacemaker</b></p>                                                                                                                                                                                          | <p><b>Dual chamber pace maker</b></p>                                                                                                                                                                                                                       |
| <p>A spike precedes each QRS complex</p>                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>- Two spikes :             <ul style="list-style-type: none"> <li>○ spike precedes each QRS complex</li> <li>○ another spike is seen before P wave</li> </ul> </li> </ul>                                                                                                                               |
| NB: If pacemaker spike is not followed by a complex , this means failure of pacing = pacemaker malfunction                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                |
| ❖ <b>Electrolyte disturbance</b>                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                |
| <p>Disorder &amp; Causes</p> <ul style="list-style-type: none"> <li><b>Hyperkalemia:</b></li> <li>- Renal failure</li> <li>- Addison syndrome</li> <li>- Acidosis</li> </ul>                                                                                                                                  | <p>ECG</p> <p>In sequences :</p> <ol style="list-style-type: none"> <li>1. Hyperacute T wave</li> <li>2. Long PR interval</li> <li>3. Lost P wave</li> <li>4. Wide QRS complex (&gt;2.5SS)</li> <li>5. Sine wave pattern</li> <li>6. Asystole</li> </ol>  |



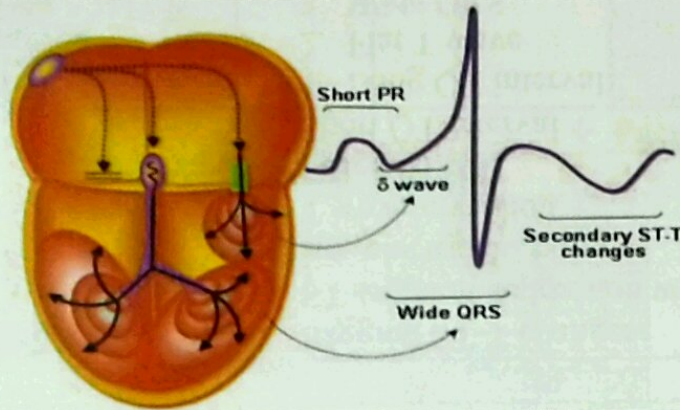
|                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li><b>Hypokalemia :</b> <ul style="list-style-type: none"> <li>- Diuretic therapy</li> <li>- Secretory diarrhea</li> <li>- Cushing syndrome</li> </ul> </li> </ul>                | <ol style="list-style-type: none"> <li>1. ST segment depression</li> <li>2. Prominent U wave ( fused to T wave )</li> <li>3. Long QT interval ( normal QT interval = <math>\frac{1}{2}</math> RR )</li> </ol>                                                            |  <p>ECG tracing showing ST segment depression and a prominent U wave. Labels: Depressed ST segment, Prominent U Wave, Biphasic T wave.</p>                |
| <ul style="list-style-type: none"> <li><b>Hypocalcemia :</b> <ul style="list-style-type: none"> <li>- Malabsorption</li> <li>- Pancreatitis</li> <li>- Hypoparathyroidism</li> </ul> </li> </ul>                      | <p>Long QT interval</p>                                                                                                                                                                                                                                                  |  <p>ECG tracing labeled B showing a long QT interval.</p>                                                                                                |
| <ul style="list-style-type: none"> <li><b>Hypercalcemia :</b> <ul style="list-style-type: none"> <li>- Hyperparathyroidism</li> <li>- Paget's diseases of the bone</li> <li>- Multiple myeloma</li> </ul> </li> </ul> | <p>Short QT interval</p>                                                                                                                                                                                                                                                 |  <p>ECG tracing labeled A showing a short QT interval.</p>                                                                                               |
| ❖ <b>Drugs</b>                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                             |
| <p><b>Digitalis effect</b></p>                                                                                                                                                                                        | <ol style="list-style-type: none"> <li>1. Sagging ST-T changes: <ul style="list-style-type: none"> <li>- ST segment depression with iso- electrical J point</li> <li>- T wave inversion</li> <li>- Fused ST &amp; T</li> </ul> </li> <li>2. Short QT interval</li> </ol> |  <p>ECG tracings labeled A and B showing digitalis effect.</p>                                                                                           |
| <p><b>Quinidine ,<br/>Procainamide &amp;<br/>Disopyramide</b></p>                                                                                                                                                     | <ol style="list-style-type: none"> <li>1. Long QT interval</li> <li>2. Flat T wave</li> <li>3. Wide QRS</li> <li>4. Prominent U wave</li> </ol>                                                                                                                          |  <p>ECG tracing showing wide QRS, flat T wave, and prominent U wave. Labels: 1 (QT interval), 2 (flat T wave), 3 (wide QRS), 4 (prominent U wave).</p> |



# ❖ Pre-excitation syndromes= Short PR interval

## Wolff Parkinson White syndrome (WPW)

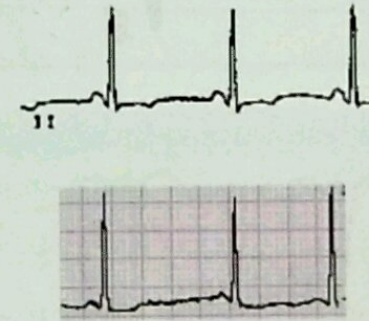
- Accessory pathway from atria to ventricles parallel to AV-junction but :
  - It has no delay of conduction
  - It conduct impulses from atria to ventricles & vice versa



Short PR interval & wide QRS & Delta wave ( initial slowing of QRS ) = Wolff Parkinson White Syndrome

## Lown Ganong Levine ( LGL)

- Accessory pathway that connects the atria directly to the bundle of His.



Short PR interval  
NO delta wave , NO wide QRS

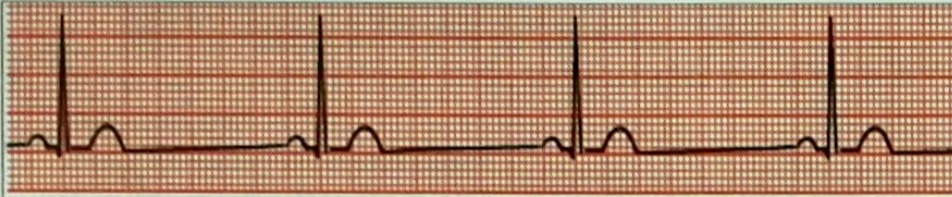
## • Revise from your theoretical book the followings :

- Angina
- Myocardial infarction
- Arrhythmias ( causes , treatment )
- Causes of atrial and ventricular enlargement.
- Attached with the book a CD which contains, more than 150 ECG exercises with the model answer.





## ECG exercises



Answer: Sinus bradycardia



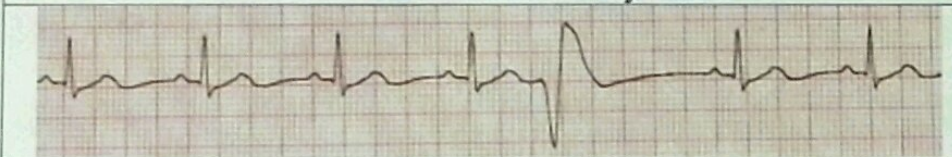
Answer: Sinus tachycardia



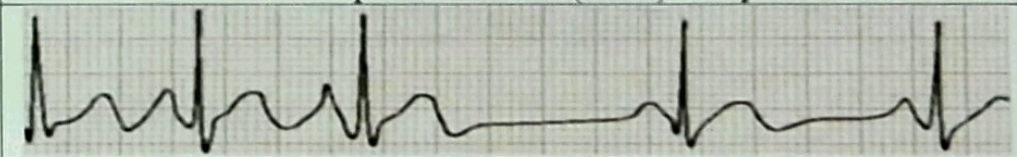
Answer: Ventricular tachycardia



Answer: Supraventricular (atrial) tachycardia



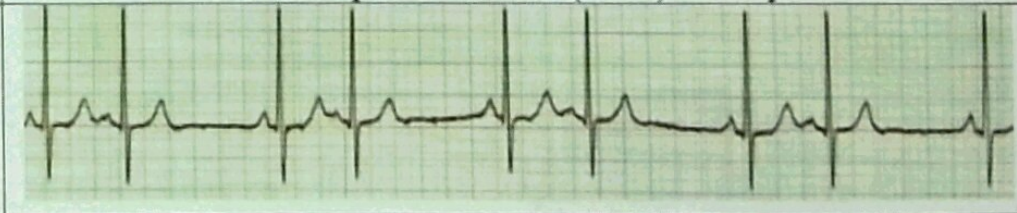
Answer: Ventricular extrasystole



Answer: Supraventricular (atrial) extrasystole



Answer: Ventricular Bigeminy



Answer: Atrial Bigeminy

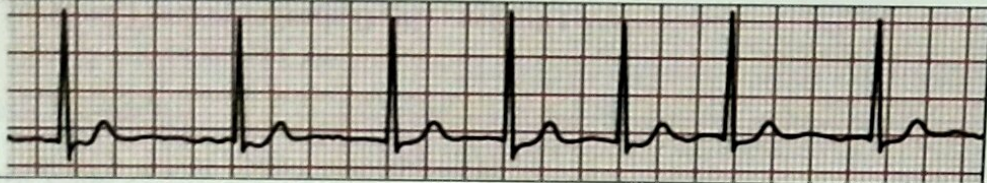
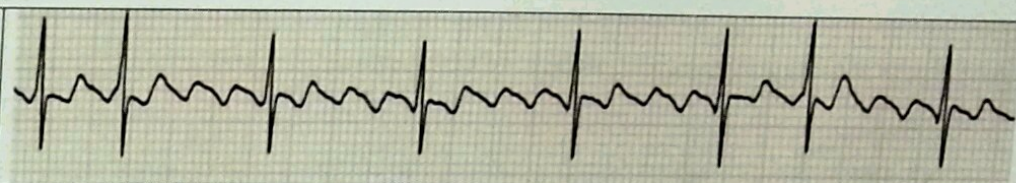
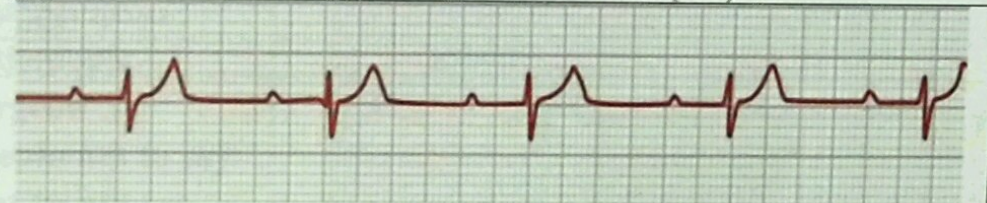
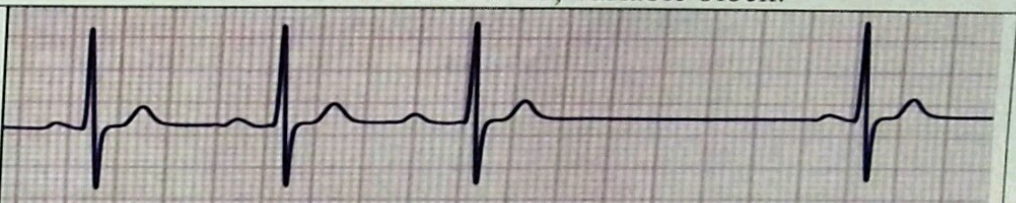
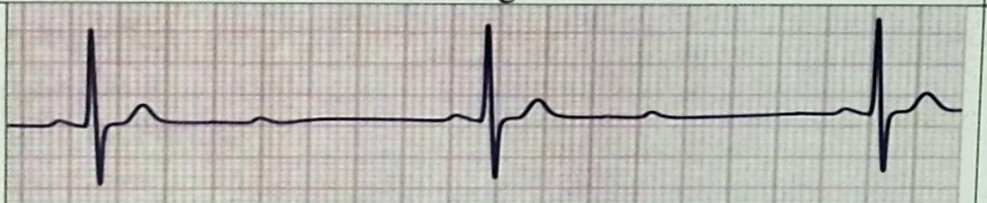
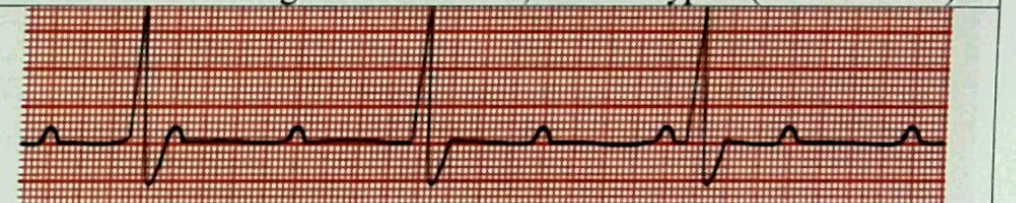


Answer: Ventricular Trigeminy



Answer: Atrial Trigeminy

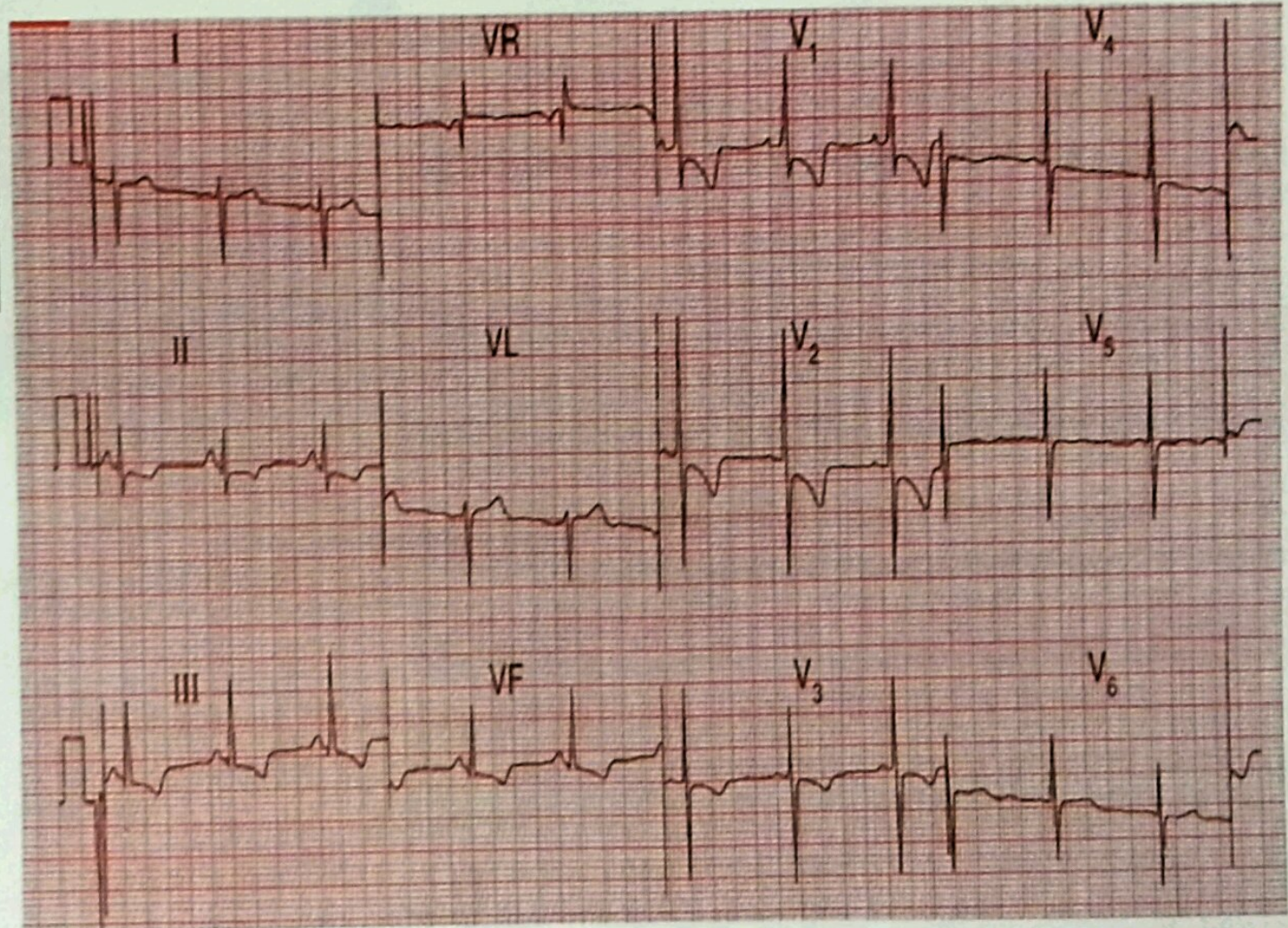


|                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                            |   |
| Answer: Atrial fibrillation (AF)                                                                                                                                                                                                                                                                                                                                                                                                                            | Answer: Atrial flutter, variable block.                                             |
|                                                                                                                                                                                                                                                                                                                                                                           |  |
| Answer: First degree heart block                                                                                                                                                                                                                                                                                                                                                                                                                            | Answer: Second degree heart block ; Mobitz type I (Wenckebach)                      |
|                                                                                                                                                                                                                                                                                                                                                                           |  |
| Answer: Second degree heart block ; Mobitz type II                                                                                                                                                                                                                                                                                                                                                                                                          | Answer: Third degree (complete) heart block                                         |
| <b>Report for complete ECG :</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                     |
| <ol style="list-style-type: none"> <li>1. Rhythm</li> <li>2. Rate</li> <li>3. Axis</li> <li>4. Lead II &amp; ( Lead I for LPHB) <ul style="list-style-type: none"> <li>• P wave</li> <li>• PR interval</li> <li>• QRS ; Pathological Q</li> <li>• ST segment</li> <li>• T wave</li> <li>• LAHP</li> </ul> </li> <li>5. (V1 ,V2) &amp; (V5,V6) : <ul style="list-style-type: none"> <li>➤ BBB</li> <li>➤ VH</li> <li>➤ Pathological Q</li> </ul> </li> </ol> |                                                                                     |



**Case History:**

A 40 year old woman is referred to the outpatient department because of increasing breathlessness.

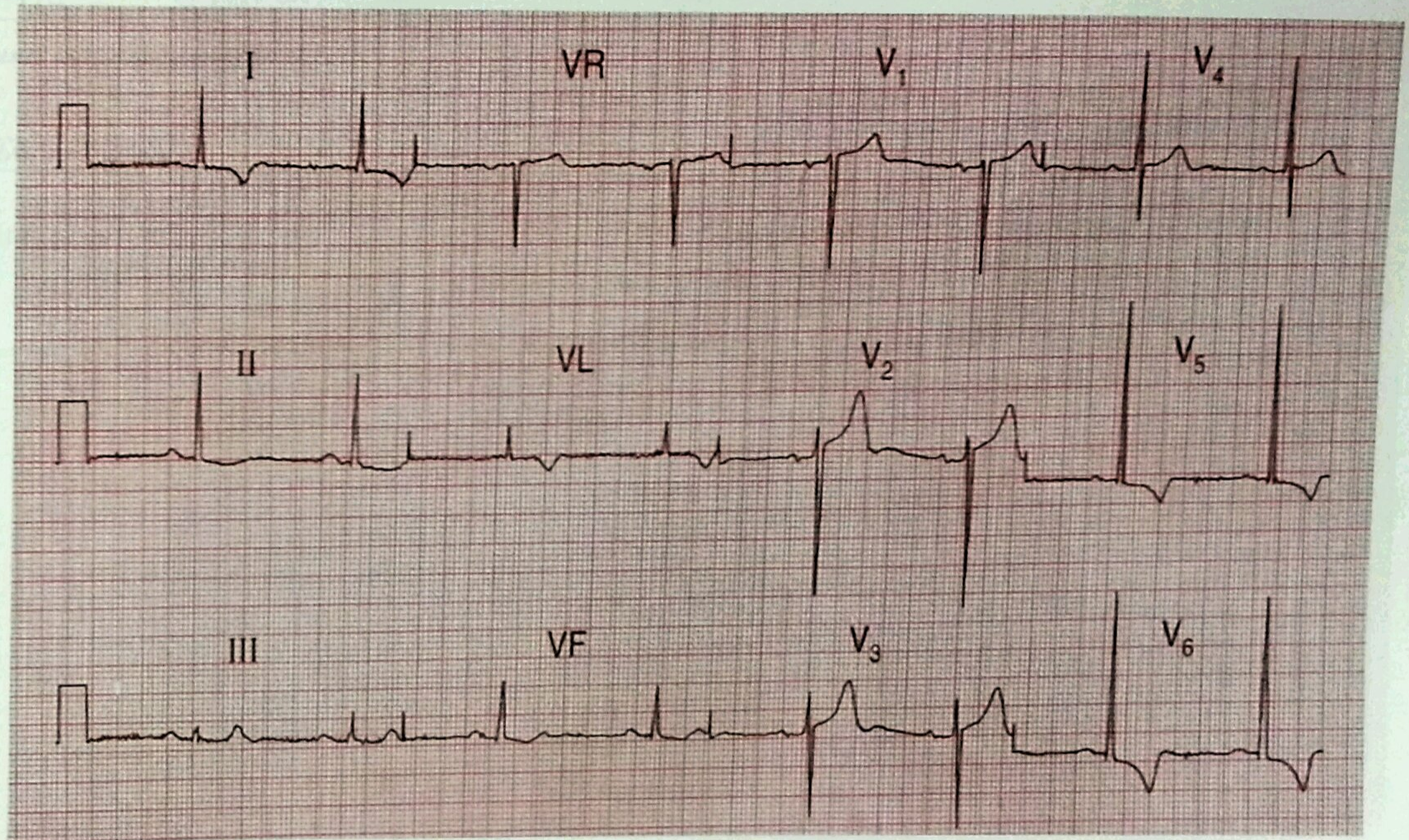


| Report                                                                                                                                                                                                                                                                                                               | Diagnosis                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"> <li>- Sinus rhythm</li> <li>- Peaked p waves , best seen in lead II</li> <li>- Right Axis Deviation (RAD)</li> <li>- Dominant R waves in lead V1</li> <li>- Deep S waves in lead V6</li> <li>- Inverted T waves in leads II , III , aVF , V1-V3</li> </ul> | <p>Severe right ventricular hypertrophy</p> |



### Case History:

A 70 year old retired orthopedic surgeon telephones to say that he always gets dizzy playing golf. You find that he has a systolic murmur.

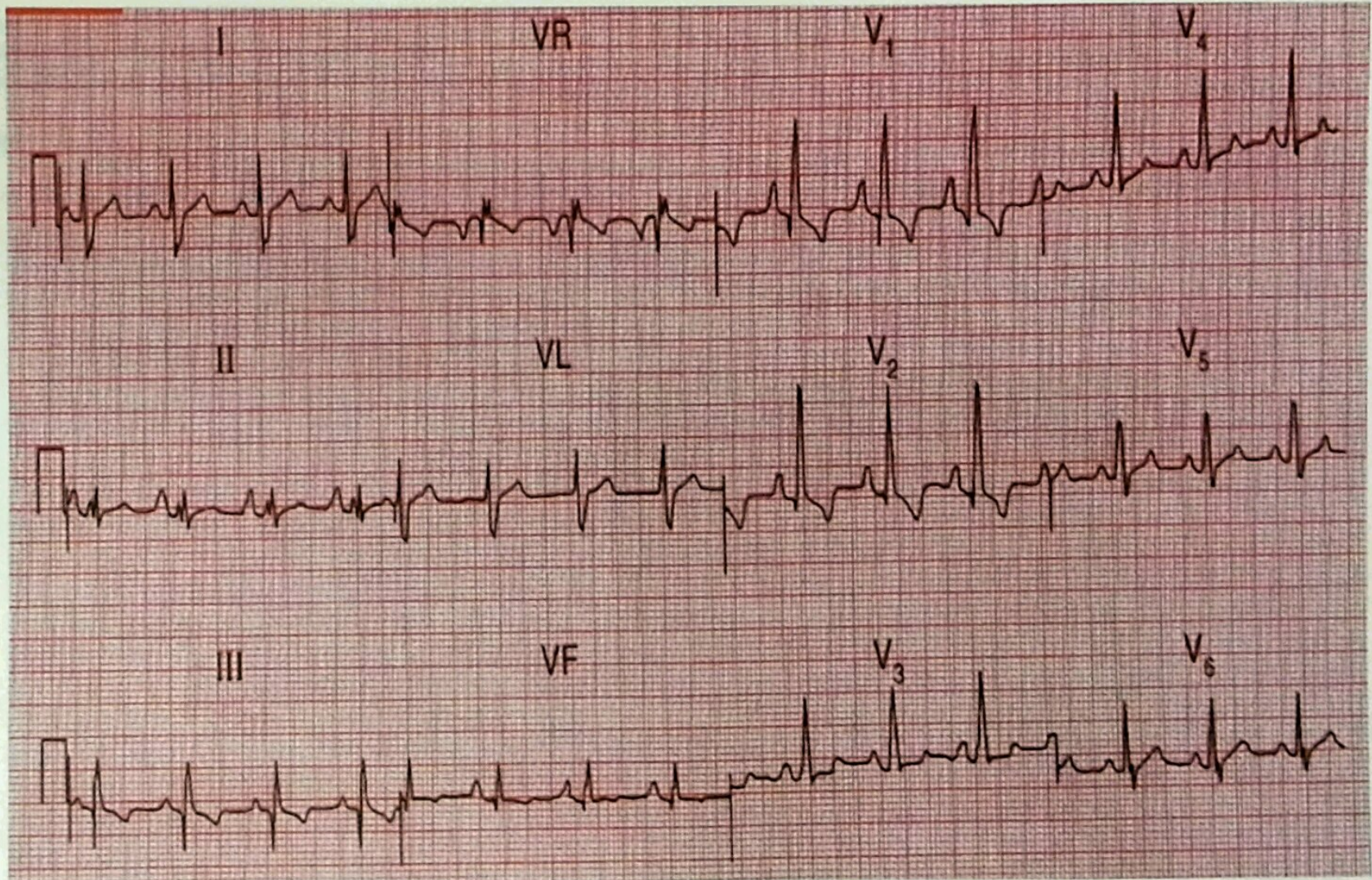


| Report                                                                                                                                                                                                                                                                                                                        | Diagnosis                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"><li>- Sinus rhythm , rate 48/min</li><li>- Normal axis</li><li>- QRS complex duration normal, but the R wave height in lead V5 is more than 25 mm , and the S wave depth in lead V2 is more than 25 mm</li><li>- Inverted T waves in leads I , avL , V5-V6</li></ul> | Left ventricular hypertrophy |



**Case History:**

This ECG recorded from a 17 year old girl who was breathless, hand marked ankle swelling with signs of right heart failure, and who had been known to have a heart murmur since birth. She was acyanotic.

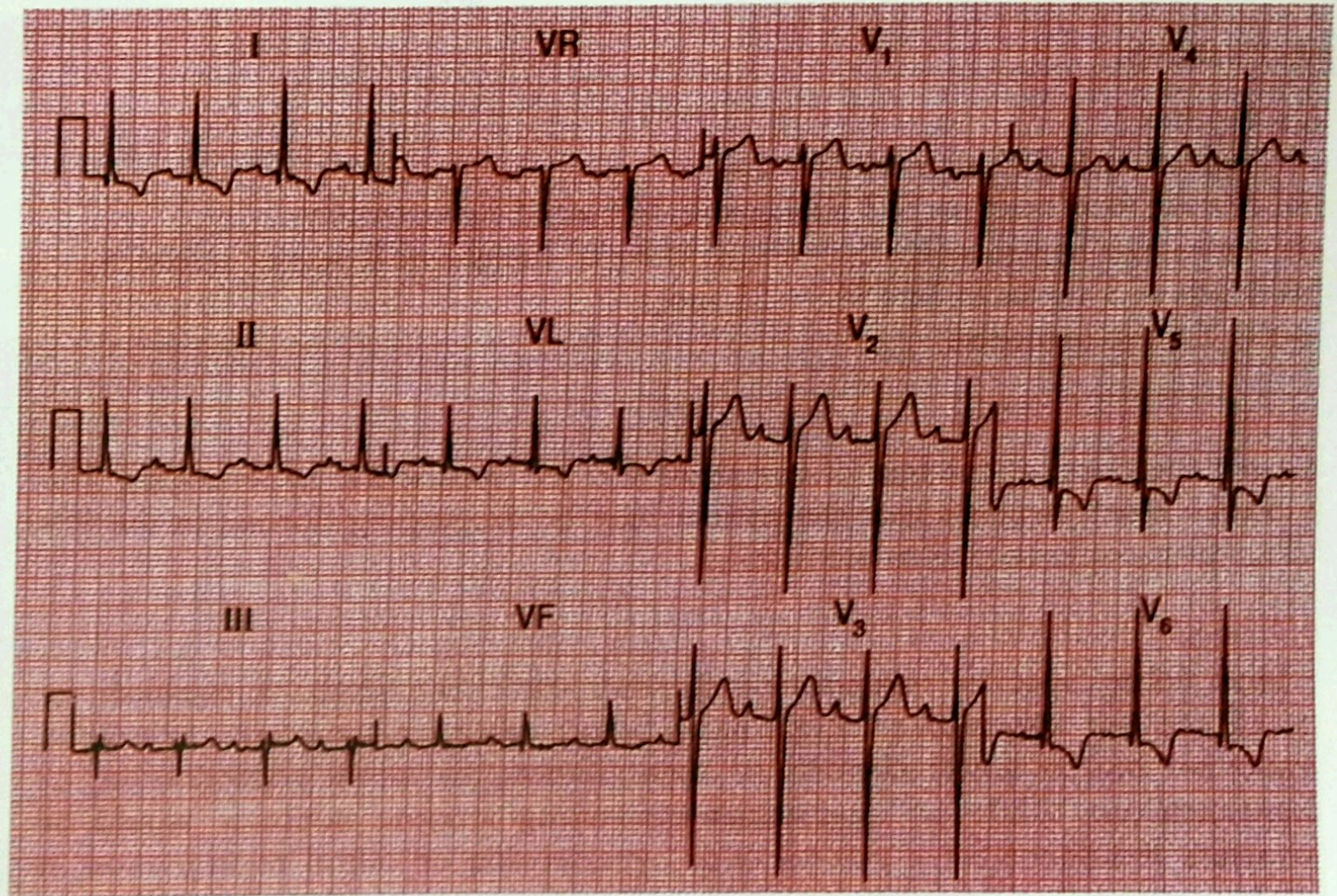


| Report                                                                                                                                                                                                               | Diagnosis                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"> <li>- Sinus rhythm</li> <li>- Markedly peaked P waves , best seen in leads II , V1</li> <li>- Normal axis</li> <li>- Dominant R wave in lead V1</li> </ul> | <p>Right atrial and right ventricular hypertrophy</p> |



### Case History:

This ECG was recorded from a 60 year old man admitted to hospital with severe heart failure

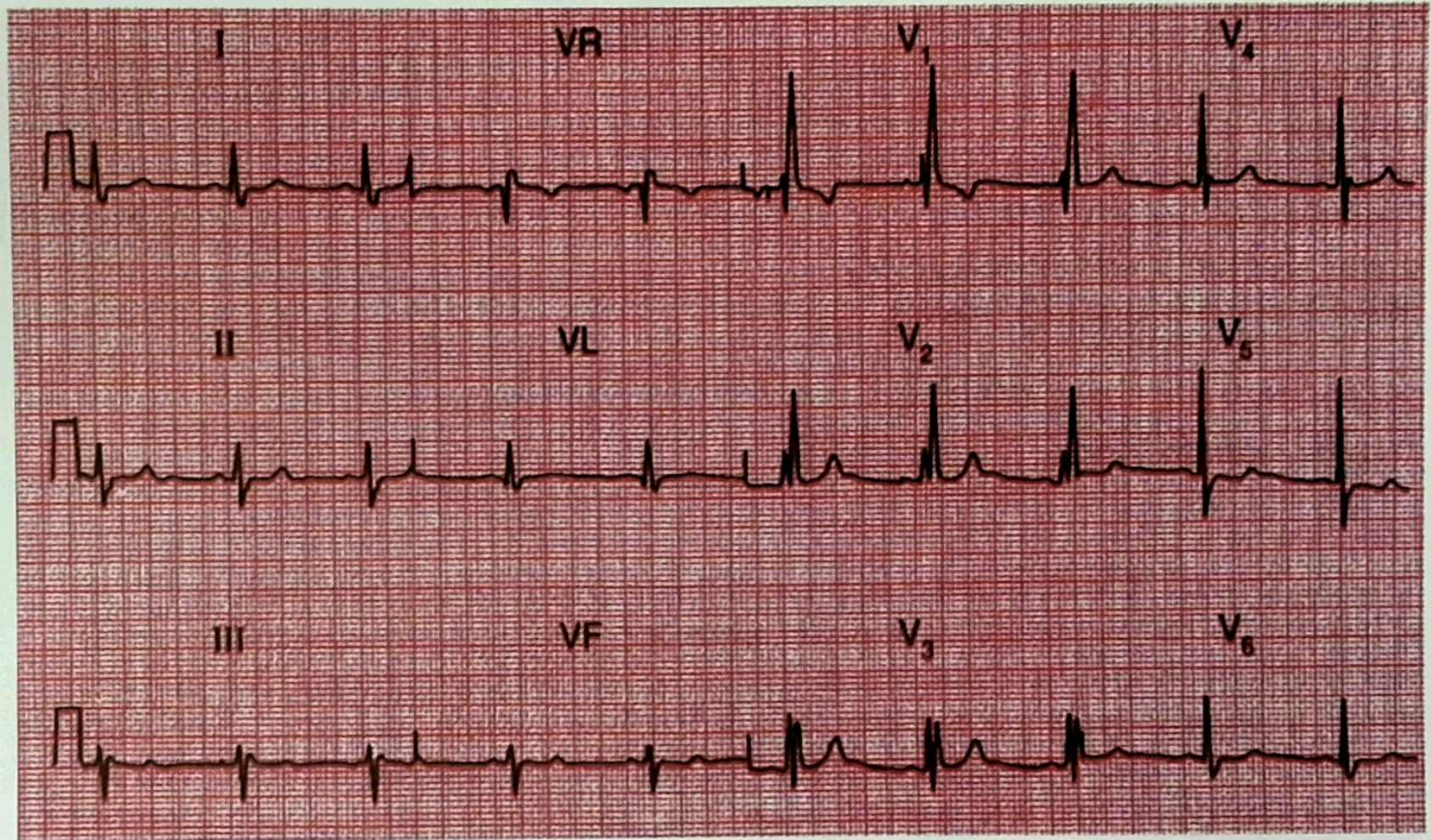


| Report                                                                                                                                                                                                                                                                                                                                                                              | Diagnosis                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"> <li>- Sinus rhythm</li> <li>- First degree heart block ( PR interval 280 ms )</li> <li>- Bifid P wave (best seen in lead II) suggests left atrial hypertrophy</li> <li>- R wave height in lead V5 is more than 25 mm , and the S wave depth in lead V2 is more than 25 mm suggest left ventricular hypertrophy</li> </ul> | <ul style="list-style-type: none"> <li>- First degree heart block</li> <li>- Left atrial hypertrophy</li> <li>- Left ventricular hypertrophy</li> </ul> |



**Case History:**

A 15 year old boy was referred to the outpatient department because of heart murmur. He had no symptoms

**Report**

- The ECG shows :
- Sinus rhythm
- Normal axis
- RBBB : Broad (wide) QRS complexes ,RSR' pattern in leads V1 – V3
- Wide and slurred S waves in lead V6
- Normal ST segments and T waves

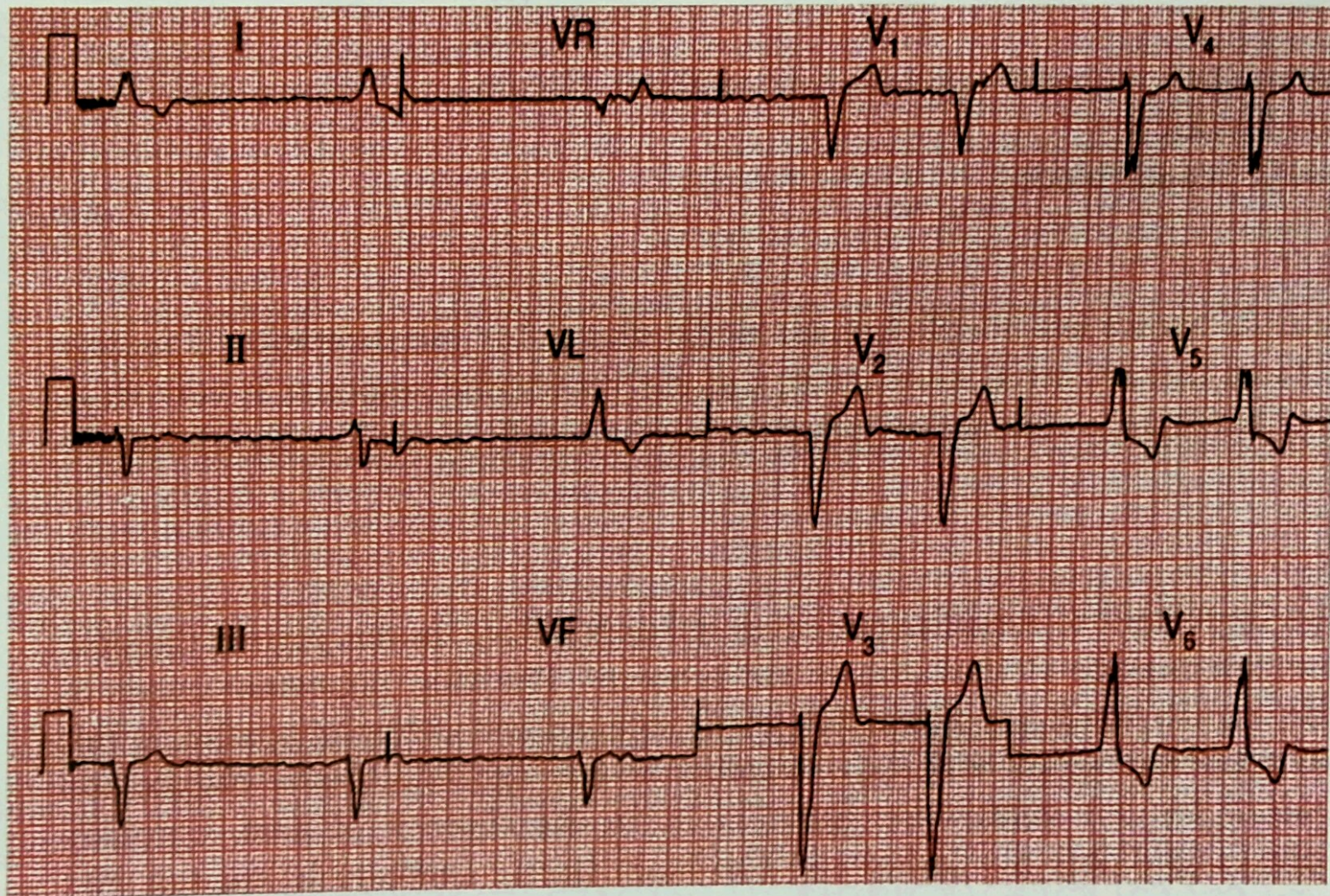
**Diagnosis**

Sinus rhythm with right bundle branch block



### Case History:

This ECG was recorded from an 80 year old man complained of breathlessness and ankle swelling which had become very slowly over the preceding few months. He had had no chest pain and was on no treatment. He had a slow pulse, and signs of heart failure



### Report

- The ECG shows :
- Atrial fibrillation with a ventricular rate about 40/min
  - Left axis deviation
  - Left bundle branch block : Monophasic notched R in V5 , V6, lead I

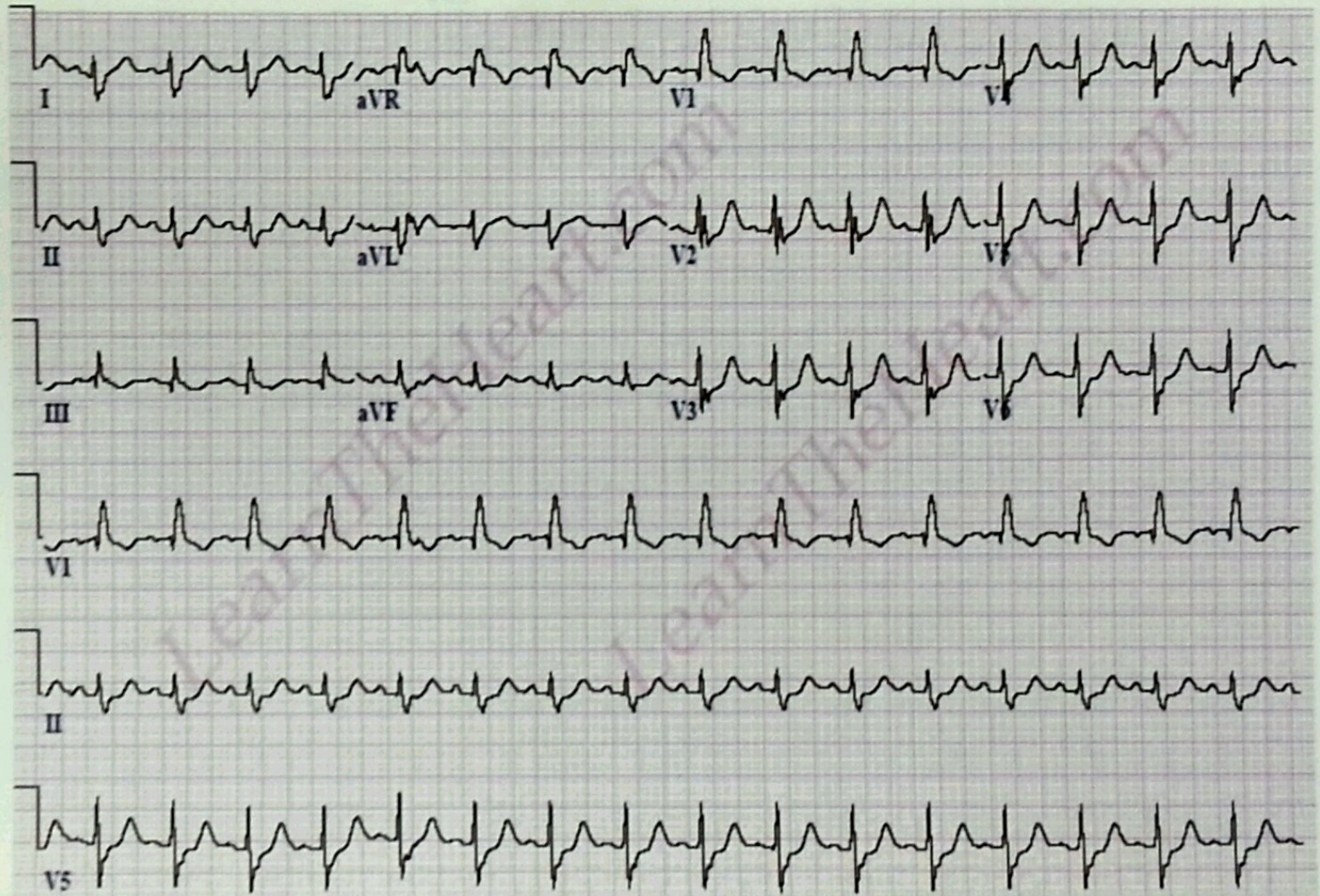
### Diagnosis

Atrial fibrillation and left bundle branch block



**Case History:**

An 80 year old woman complained of breathlessness and frequent attacks of dizziness. This was her ECG when she attended the clinic. She lived alone, and it seemed unlikely that she could cope with an ambulatory recorder.

**Report**

The ECG shows :

- Sinus rhythm
- Right axis deviation
- Left posterior hemiblock : RAD + Deep S wave in I & aVL
- Right bundle branch block : Broad (wide) QRS complexes , rSR' pattern & monophasic notched tall R , in leads V1 – V3

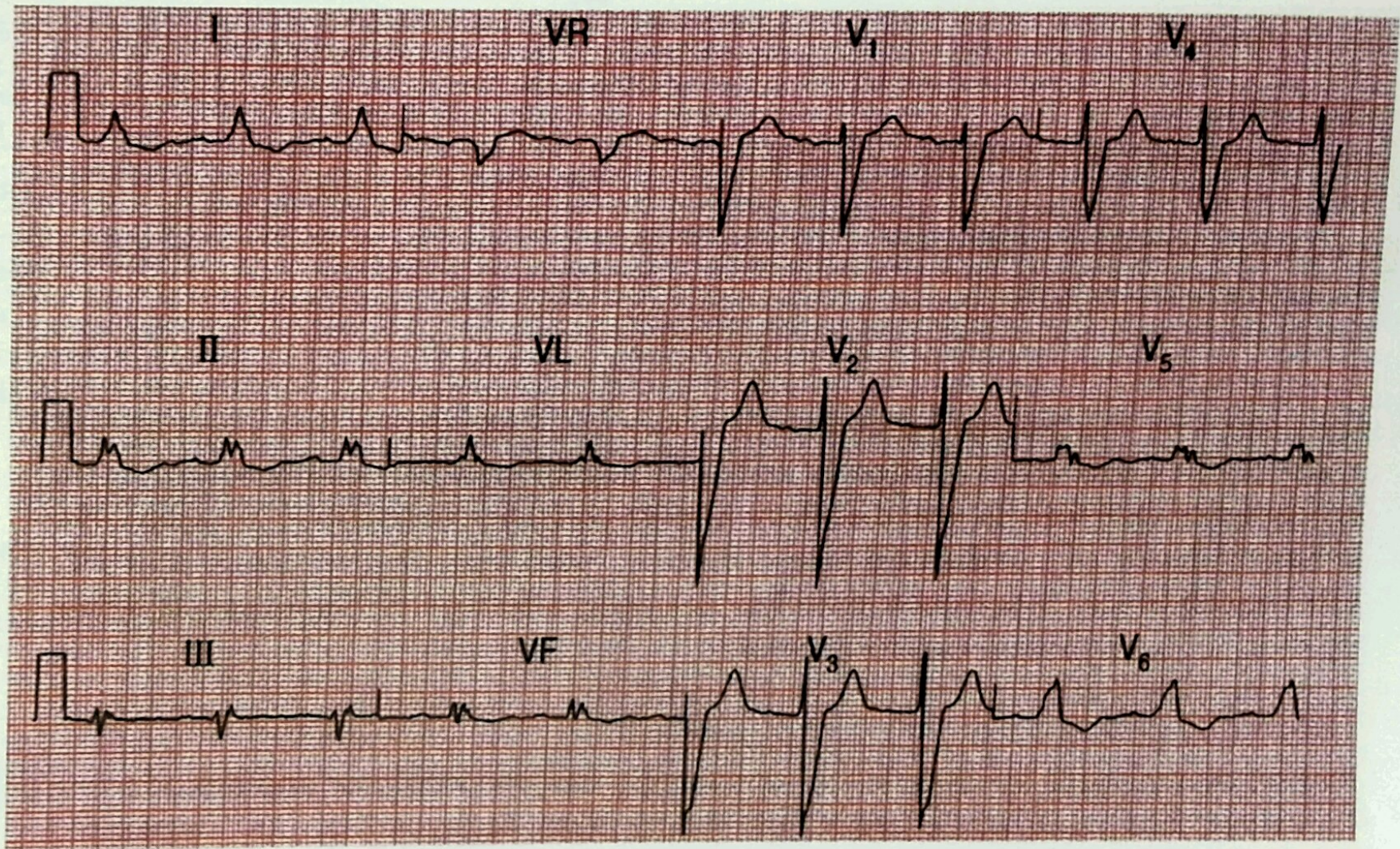
**Diagnosis**

Bifascicular block = Left posterior hemiblock +  
right bundle branch block



### Case History:

This ECG was recorded after cardioversion, when the patient was well. His serum troponin level remained normal following the admission, so he had not had myocardial infarction.



### Report

The ECG show :

- Sinus rhythm
- First degree block ( PR interval 220 ms) : fixed prolonged PR interval
- Normal axis
- Broad QRS complexes ( 200ms)
- Left bundle branch block : Monophasic notched R in V5 , V6, lead I

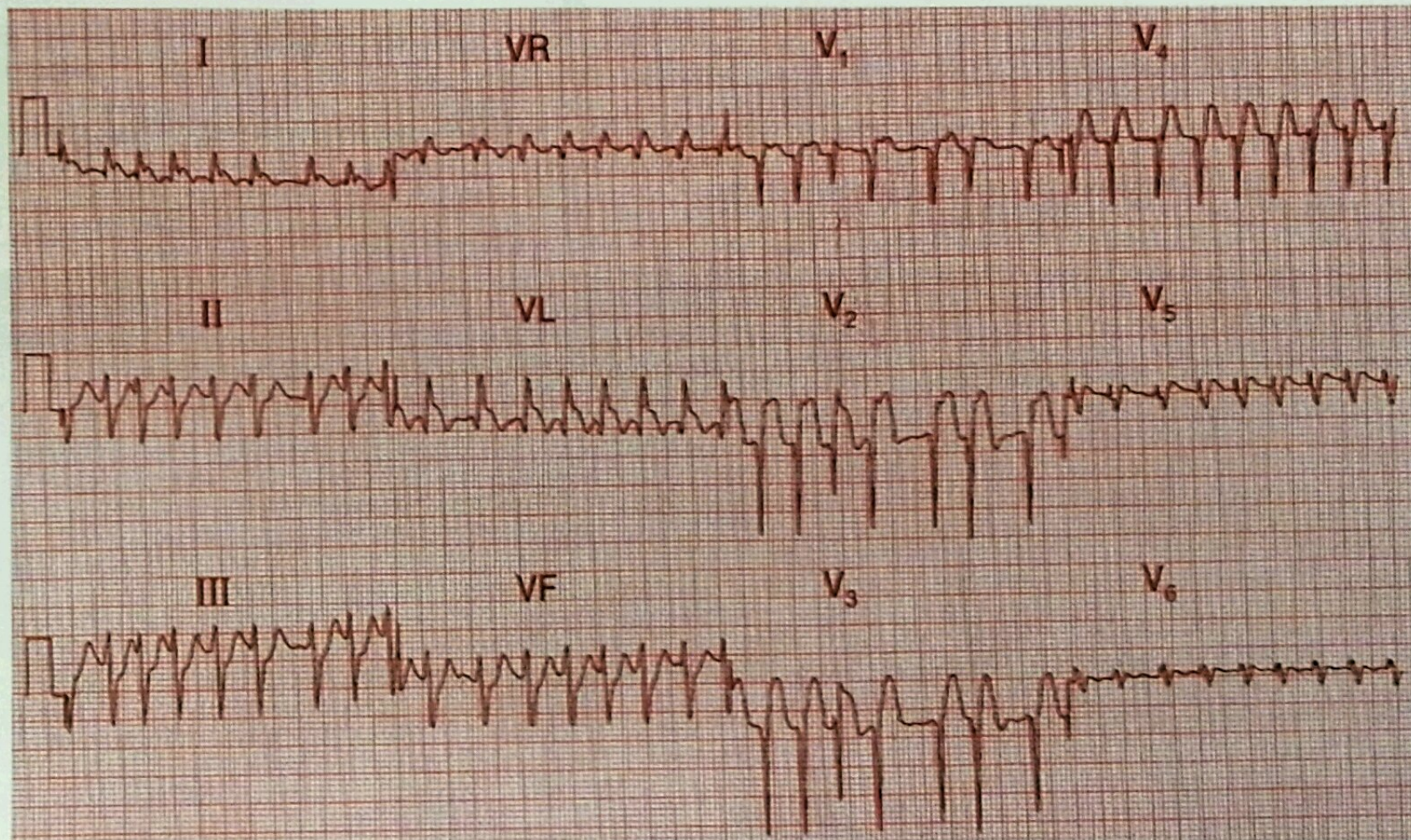
### Diagnosis

First degree heart block and Left bundle branch block



**Case History:**

This ECG recorded from diabetic man who was admitted because of the sudden onset of pulmonary edema

**Report**

The ECG shows :

- Atrial fibrillation with a ventricular rate about 180/min
- Left axis deviation
- Deep S in lead II , III , aVF
- QRS complexes of normal width and height
- Pathological Q in V2 - V4
- Raised ST segment in leads I , VL, V2-V4

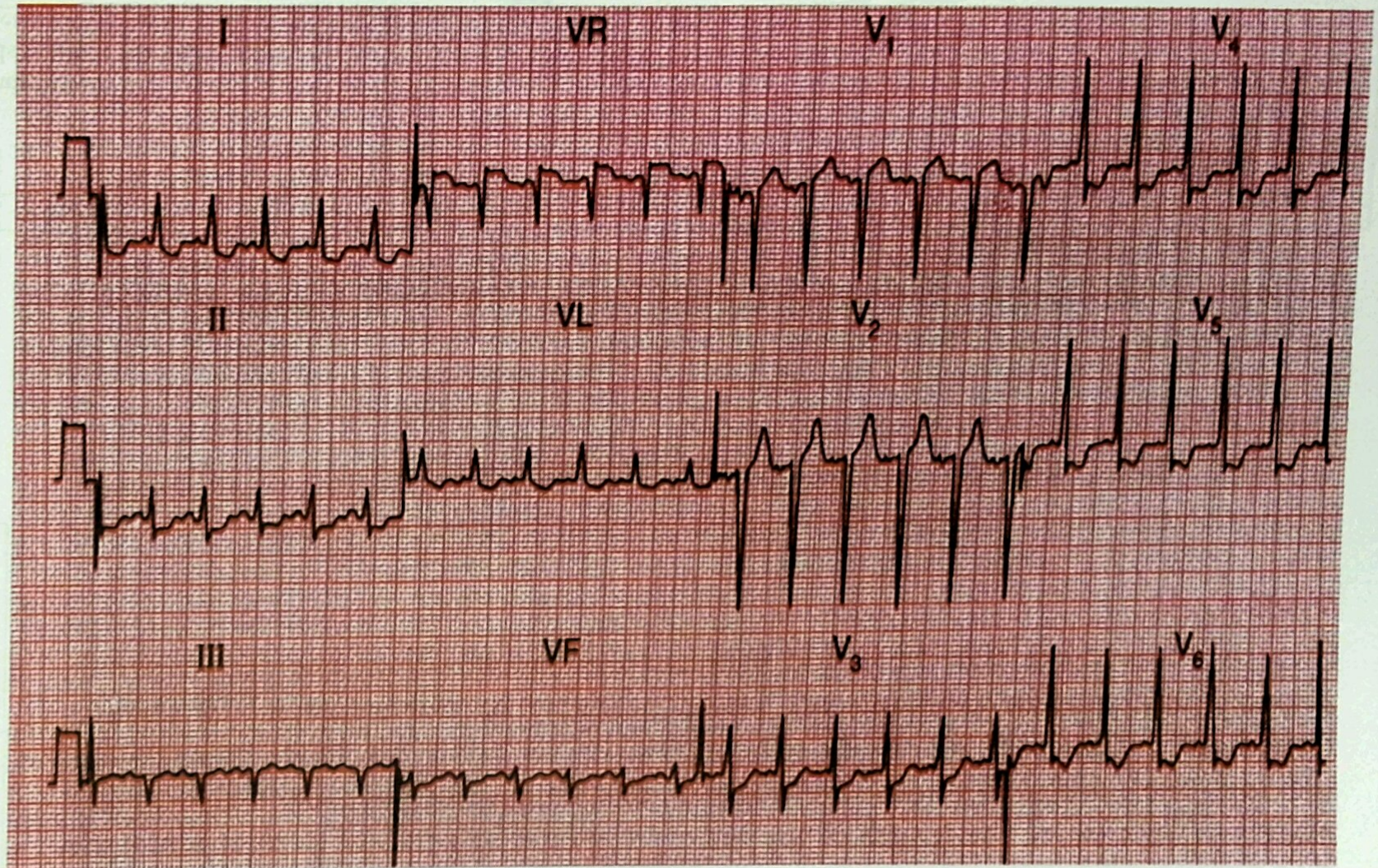
**Diagnosis**

Atrial fibrillation , left anterior hemiblock and acute anterolateral myocardial infarction



### Case History:

This ECG recorded from 55 year old man who had had chest pain at rest for 6 hours. There were no physical findings and his plasma troponin level was normal.

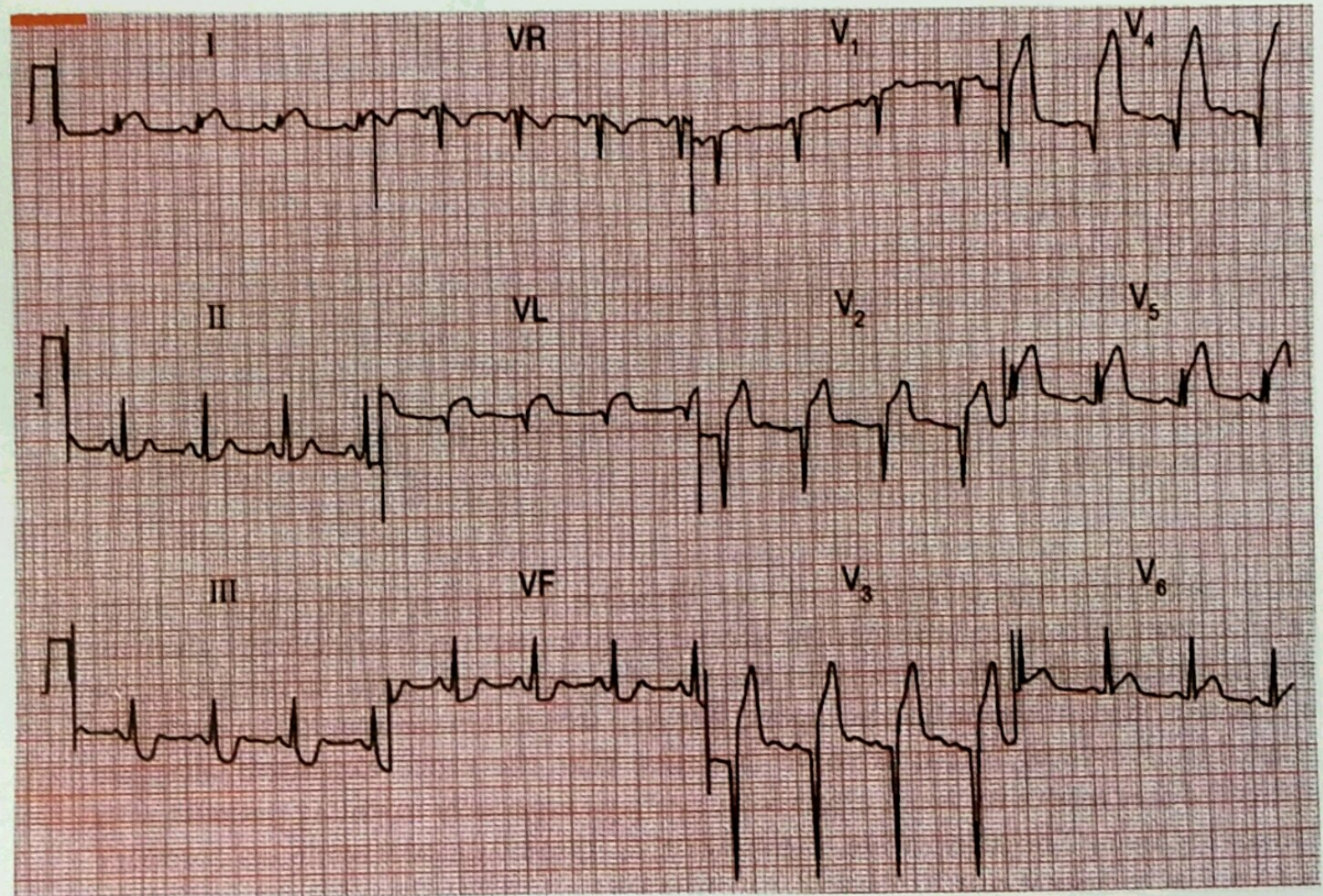


| Report                                                                                                                                                                                                                                        | Diagnosis                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| <p>The ECG shows:</p> <ul style="list-style-type: none"><li>- Sinus rhythm</li><li>- Normal axis</li><li>- Normal QRS complex</li><li>- ST segment depression – horizontal in leads V3, V4, downward sloping in leads I, aVL, V5-V6</li></ul> | <p>Anterolateral ischemia</p> |



**Case History:**

A 45 year old patient is admitted to the accident and emergency department, having severe central chest pain for 1 hour. There are no signs of heart failure.

**Report**

The ECG shows :

- Sinus rhythm
- Normal axis
- Pathological Q waves in leads V2-V4
- Raised ST segments in leads I, aVL, V2-V5
- ST segment depression in leads II, III, aVF

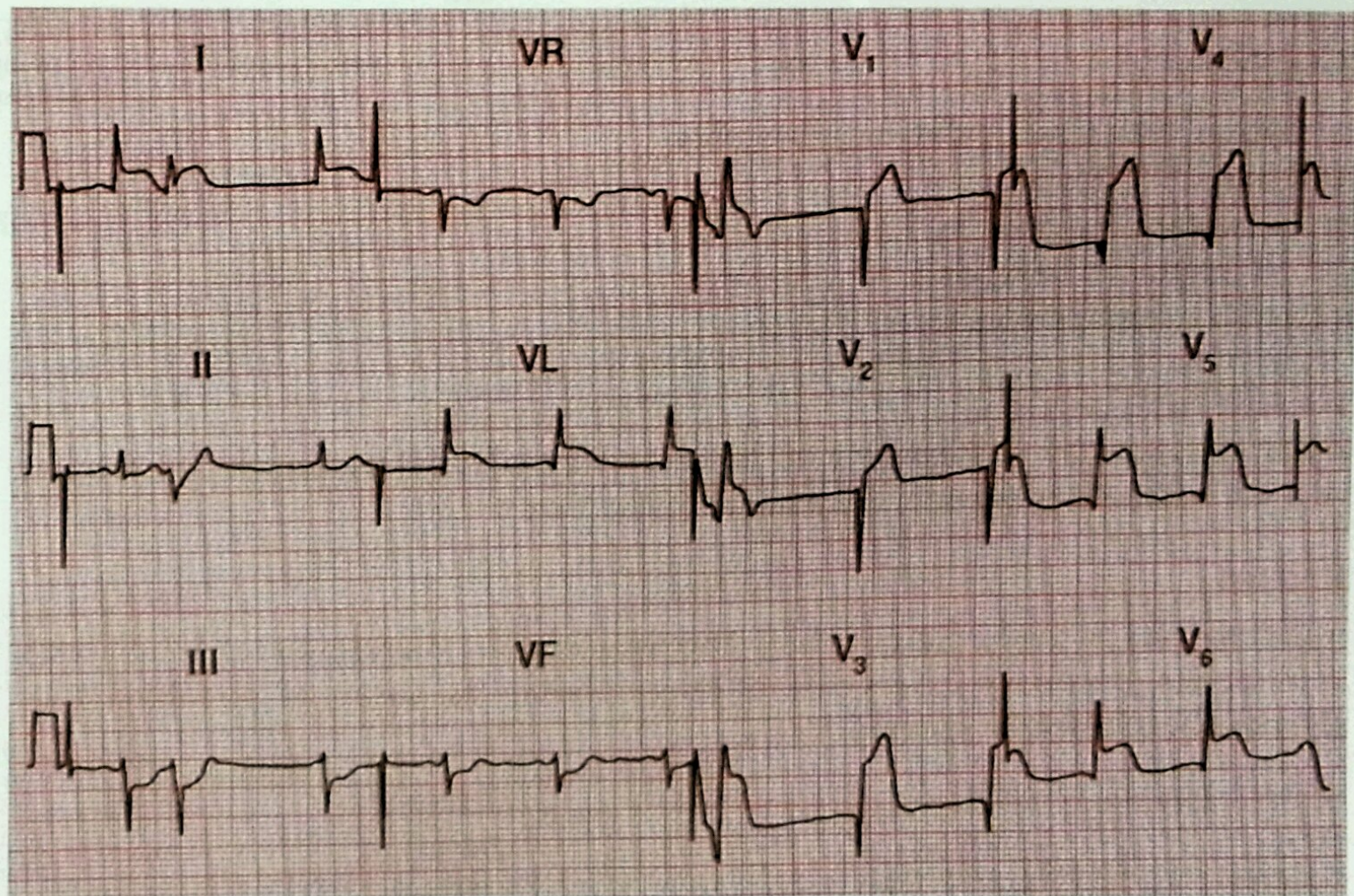
**Diagnosis**

Acute anterior myocardial infarction and inferior ischemia



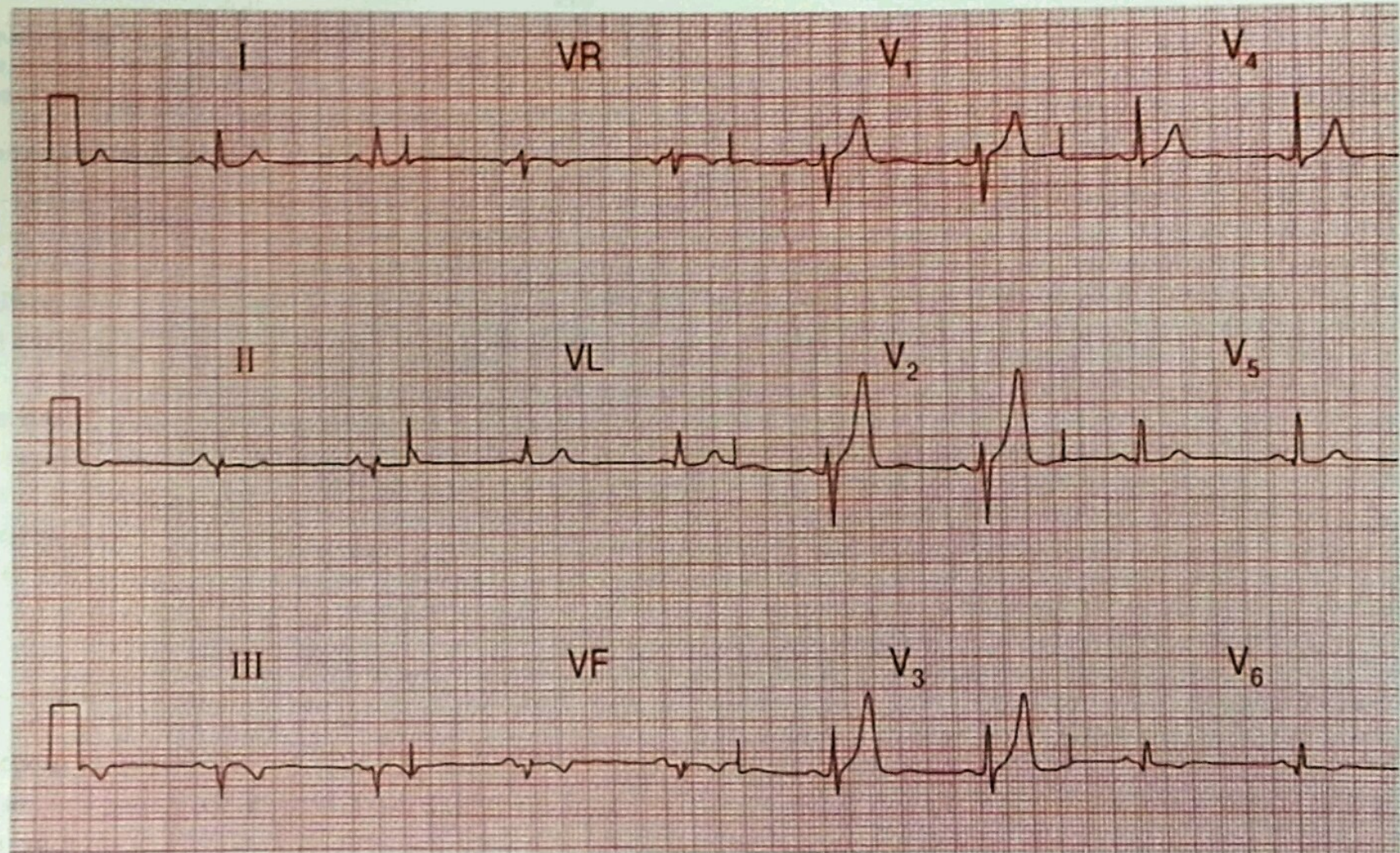
### Case History:

This ECG was recorded from a 50 year old man who had had severe chest pain for 1 h.



| Report                                                                                                                                                                                                                                                                                                  | Diagnosis                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"> <li>- Sinus rhythm with ventricular extrasystoles</li> <li>- Normal axis</li> <li>- Pathological Q waves in leads V3-V5</li> <li>- Raised ST segments in leads I , aVL , V3-V6</li> <li>- Depressed ST segments in leads III , aVF</li> </ul> | <p>Acute ST segment anterolateral myocardial infarction with ventricular extrasystoles</p> |





### Case History:

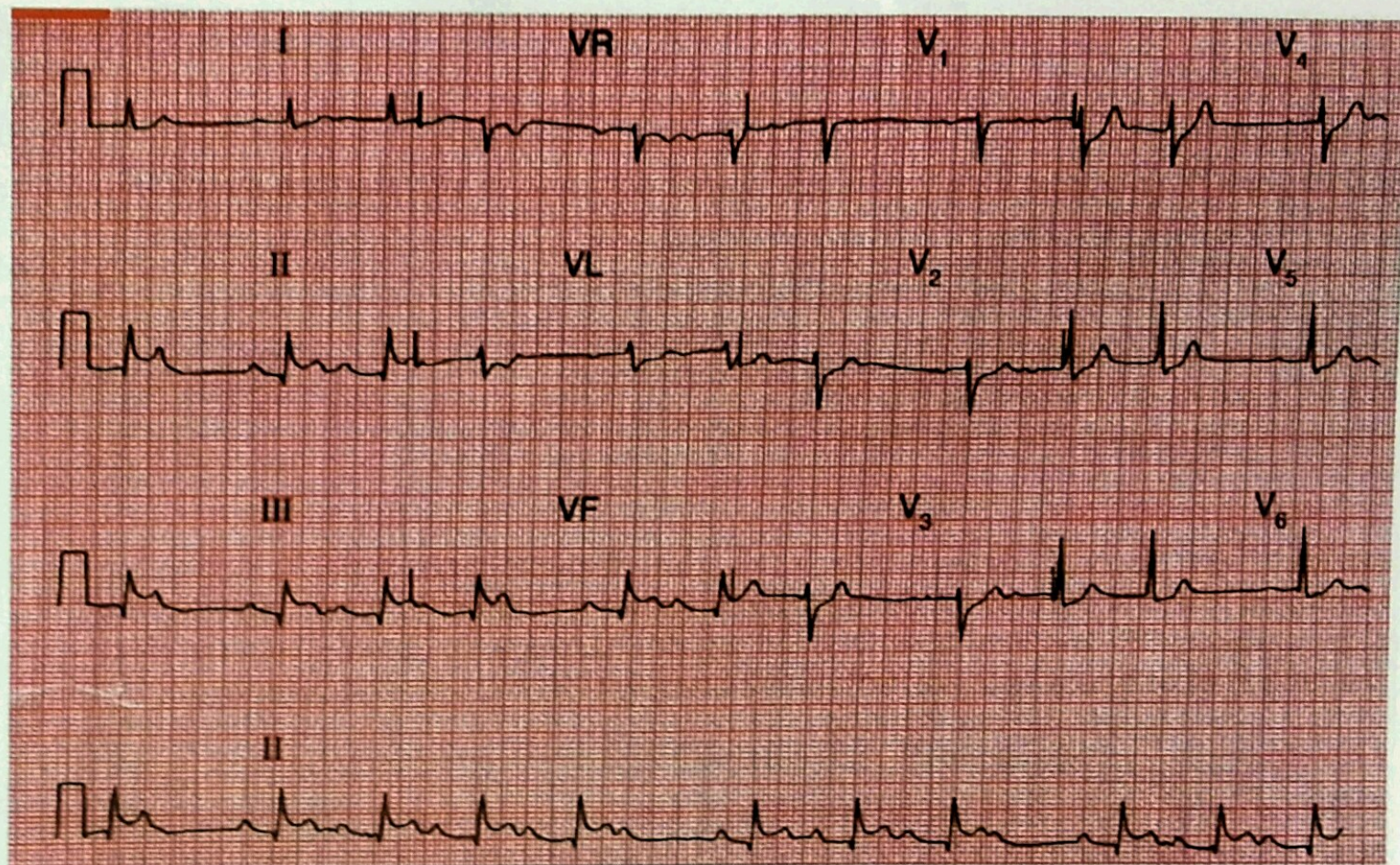
A 60 year old man was seen as an outpatient, complaining of rather vague central chest pain on exertion. He had never had pain at rest.

| Report                                                                                                                                                                                                                                                                                                        | Diagnosis                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The ECG shows:</p> <ul style="list-style-type: none"> <li>- Sinus rhythm</li> <li>- Normal axis</li> <li>- Pathological small Q waves in leads II , III , avF</li> <li>- Biphasic T waves in leads II , V6; inverted T waves in leads III , avF</li> <li>- Marked peaked T waves in leads V1-V2</li> </ul> | <p>Old inferior myocardial infarction</p> <p>NB : the Q waves in the inferior leads, together with inverted T waves, point to an old inferior myocardial infarction.</p> <p>While symmetrically peaked T waves in the anterior leads can be due to hyperkalemia, or to ischemia , they are frequently a normal variant .</p> |



### Case History:

A 70 year old man is admitted to hospital following the onset of severe central chest pain.

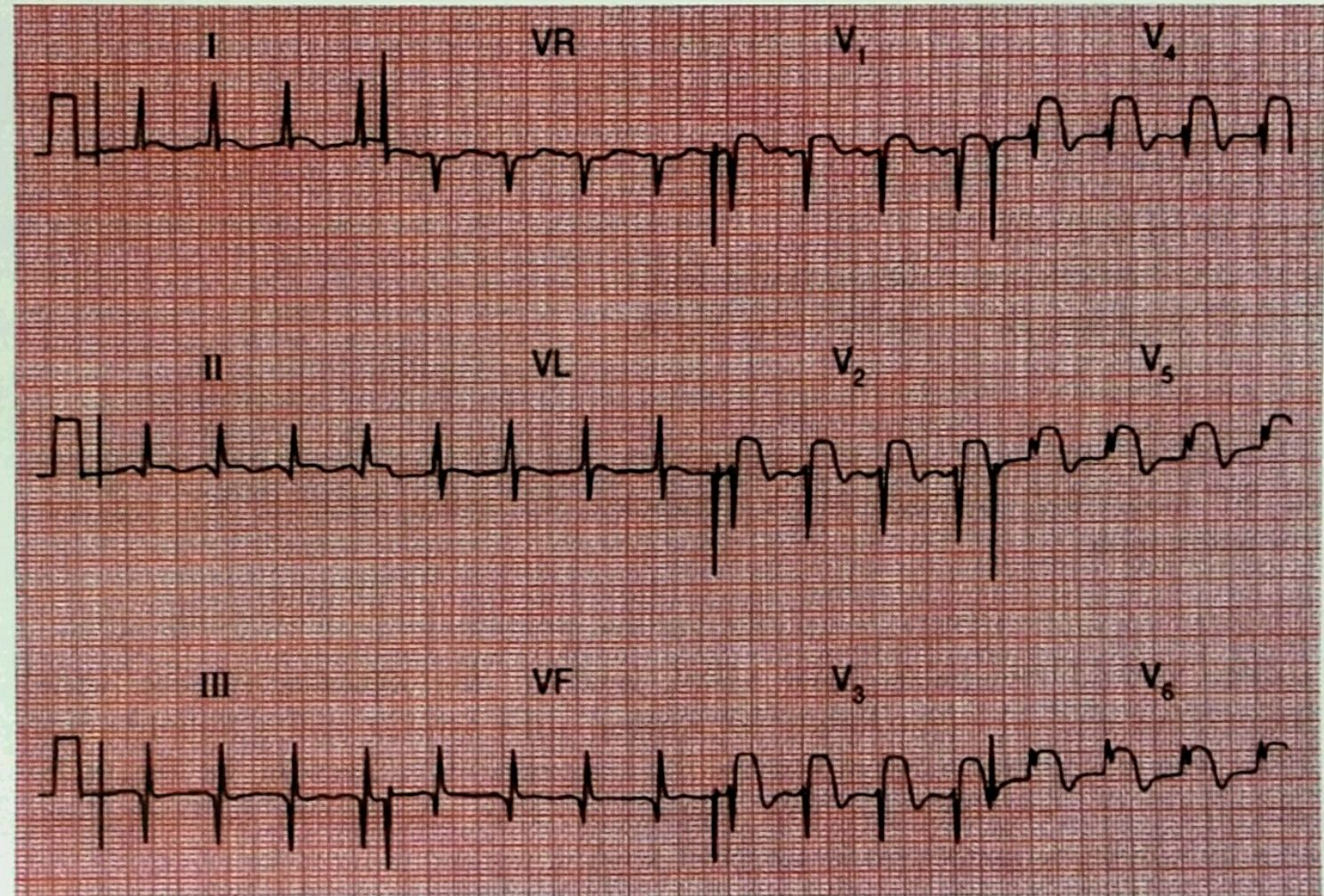


| Report                                                                                                                                                                                                                                                                                                                                                                                                                       | Diagnosis                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"> <li>- Sinus rhythm</li> <li>- Second degree (Wenckbach) hear block ( most obvious in rhythm strip recorded from lead II )</li> <li>- Ventricular rate 70/min</li> <li>- Normal axis</li> <li>- Pathological small Q waves in leads II , III , avF</li> <li>- Raised ST segments in leads II , III , avF</li> <li>- Depressed ST segments in leads V5-V6</li> </ul> | <p>Second degree (Wenckbach) atrioventricular block with acute inferior myocardial infarction .</p> |



**Case History:**

A 60 year old man, who 3 years earlier had had a myocardial infarction followed by mild angina, was admitted to hospital with central chest pain that had been present for 1 hour and had not respond to sublingual nitrates.

**Report**

The ECG shows :

- Sinus rhythm
- Normal axis
- Pathological Q waves in leads II , III , avF
- Isoelectric ST segment in Leads II , III , avF
- Normal QRS complexes in the anterior leads
- Pathological Q with Marked ST segment elevation in leads V1-V6

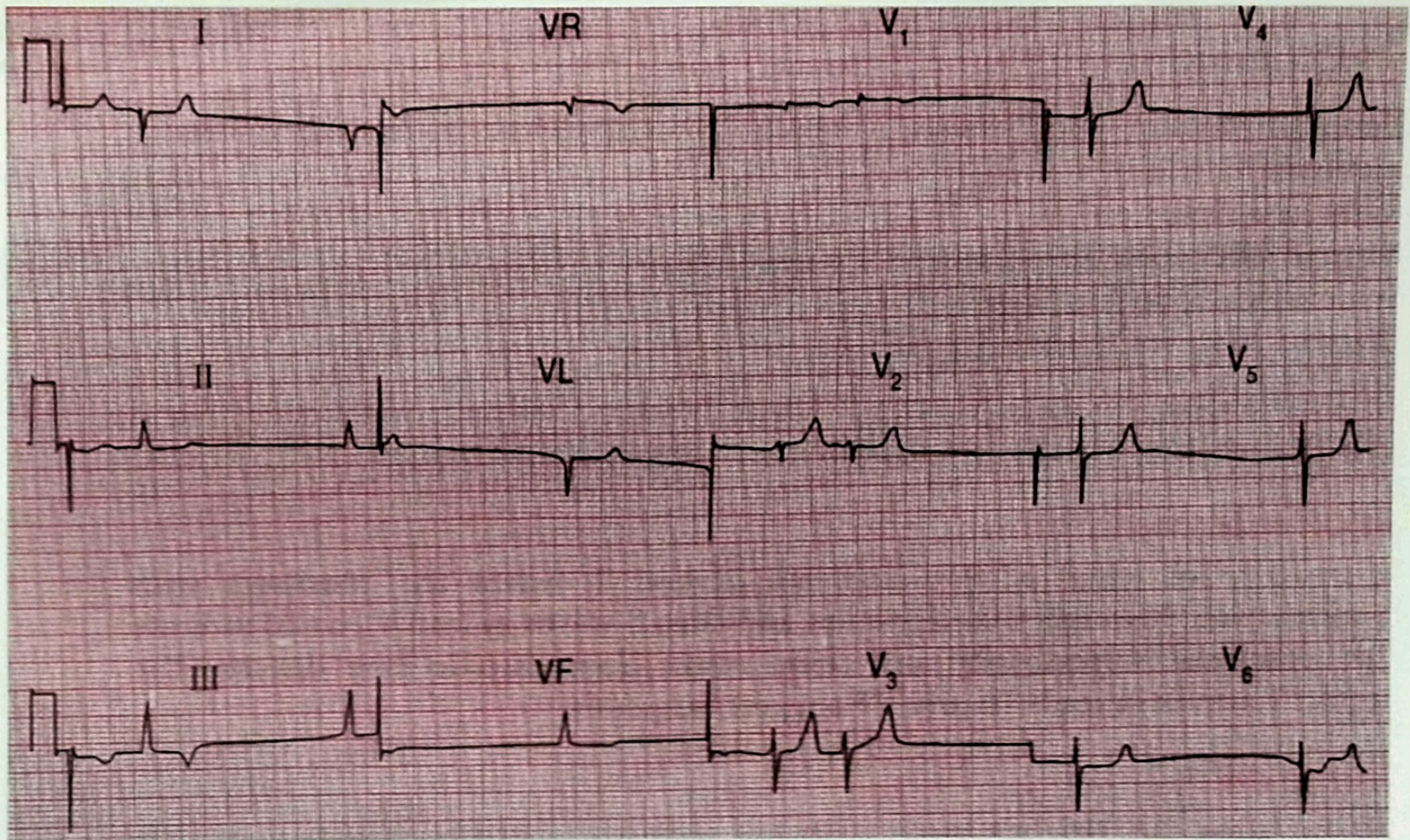
**Diagnosis**

Old inferior infarction and acute anterior infarction



### Case History:

A 65 year old woman with rheumatic heart disease, who had had severe heart failure for years, was admitted with increasing breathlessness and ankle swelling. Despite having been treated with ACEI and diuretics, there was evidence of severe heart failure.



#### Report

The ECG shows

- Uncertain rhythm , no P waves , irregular QRS complex, but no fibrillation activity
- Right axis deviation
- Normal QRS complexes except for deep S wave in lead V6
- Symmetrically peaked T waves
- Inverted T waves in leads III , aVF

#### Diagnosis

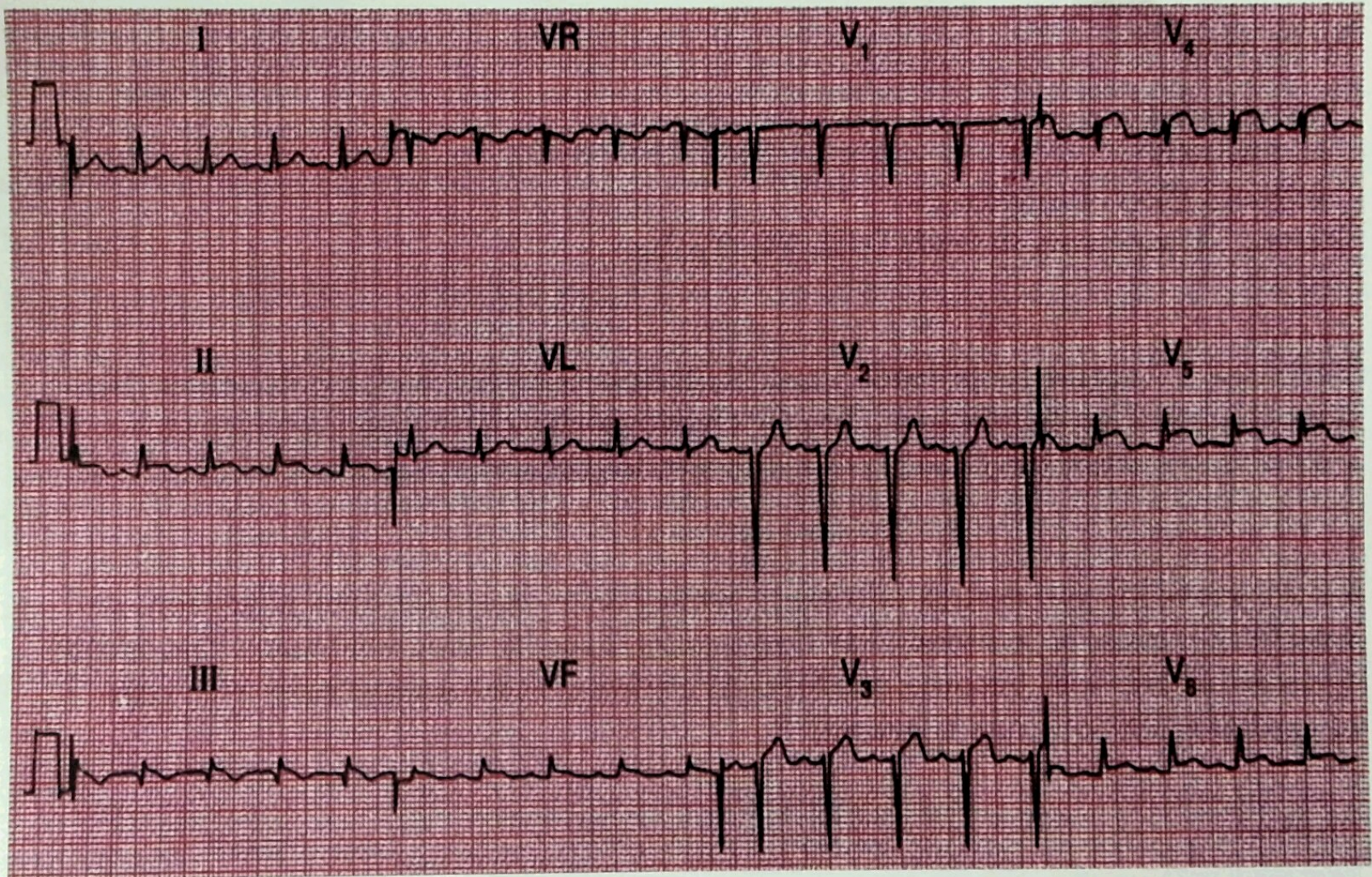
Hyperkalemia

NB: the absence of atrial activity and the peaked T waves are consistent with hyperkalemia. The right axis deviation and the deep S waves in lead V6 could indicate right ventricular hypertrophy. The inverted T waves in leads III , aVF suggest ischemia



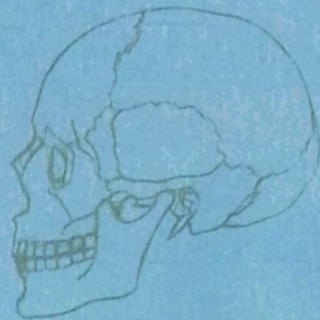
**Case History:**

A 25 year old man is admitted to the accident and emergency with severe chest pain. No physical abnormalities had been detected.



| Report                                                                                                                                                                                                    | Diagnosis                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| <p>The ECG shows :</p> <ul style="list-style-type: none"> <li>- Sinus rhythm</li> <li>- Normal axis</li> <li>- Normal QRS complexes</li> <li>- Raised ST segments in leads I-III , aVF , V4-V6</li> </ul> | <p>Wide spread ST segment elevation , suggesting pericarditis</p> |





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